SPGR Sub-Project Completion Report

Improved Potato Storage Facility for Farm Household

Duration: **January 2012 to June 2014**

Executing Organization:
Department of Farm Power and Machinery
Bangladesh Agricultural University
Mymensingh

Submitted to:
PIU-BARC, BARC Complex
Farm Gate, Dhaka-1215

June 2014

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Executive Summary

This project started functioning from January 2012 and ended in June 2014 with full financial support of SPGR, BARC to achieve the objective of developing a potato storage facility at farm household so that the storage life of potato could be increased over traditional open storage at farm house. A laboratory version of improved design of the potato store and its construction was made in the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. An evaporative cooling chamber, made of RCC, partially filled-in with water was constructed beneath the storage bin. The height and diameter of the experimental storage structure having four shelves to load the potatoes were 3.0 m and 2.0 m, respectively. Two varieties of potato (Diamant and Lal Pakri) and their two sizes (small and large) were placed on four shelves of the bin. Each shelf holds 240 kg of potato (four categories of potato, in each of 10 kg sack). For farmers' traditional storage practice similar quantity of four categories of potato were kept on C.C. floor (over a bamboo mat with a thin layer of dry sand) inside the same room in which the Improved Storage Bin was located. The required instruments such as data logger with a LabView software, solar system to power the exhaust fan of the storage bin for experimental data collection were installed. A forced air ventilation by a rotary exhaust fan, powered by solar panel, located at the top of the storage bin helped accelerate evaporate water from the evaporative chamber kept below the storage bin. Cool and moist air flow helped maintain the potato temperature below the air temperature inside the bin.

Potato samples were taken from both the storage conditions 15 days interval on the same day of sample collection. Potato spoilage, sprouting, shrinkage, moisture content of potato, vitamin C and total sugar content of potato were measured for both the methods of storage and the results were compared accordingly. In addition, air humidity and air temperature inside the bin at 16 different points were recorded using data logger and LabView software. These activities were continued up to November 2013. The results indicated that the improved storage bin performed better that the farmer's traditional storage practice. The improved storage bin could bring benefit to farmers and traders for storing both Diamant and Lal Pakri varieties but higher gross benefit and longer safe storage for Lal Pakri variety. The experimental data were thoroughly analysed to find the optimum design of potato storage bin for farm household. An improved design of potato storage bin suitable for small farm holders, having a capacity of 500 kg to 1500 kg, has been proposed. However, it needs farmers' field trial before commercialization the technology. The total cost (year 2014) of the improved storage bin, including solar system and exhaust fan, for a capacity of 1500 kg has been estimated to Tk. 38,000.00 with an expected life of 10 years.

1. **Sub-Project Title**: IMPROVED POTATO STORAGE FACILITY FOR FARM HOUSEHOLD

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4. **Duration of the Sub-project**: From January 2012 to June 2014

5. **Date of Approval** (signing of LOA) : 1st January 2012

6. **Total Approved Budget** (Tk.) : 3,836,400.00

Total fund released (Tk.) : 3,836,400.00

Total fund spent (Tk.) (including committed) : 3,836,400.00

Unspent fund (Tk.) : 00.00

7. Justification of Undertaking the Sub-project :

Potato has become one of the major food and cash crop in Bangladesh. During 2007-2008 potato coverage of 4.02 lac hectare, production of 66.5 lac MT and average productivity of 16.6 t/ha have been reported. (Rabbani et al, 2010). During 2009 - 2010 production of potato was even higher than the previous years. As a result farmers could not store it in the nearby cold storages due to limitation of storage spaces as well as lack of other community based/household storage facilities. At present only 25-30% of the total potatoes produced in the country can be preserved in cold storages. Discontinuous supply of electricity in the cold storage made it more difficult to save potato from losses. It is reported that about 12-15% of the total production of potato are lost every year due to lack of proper storage facility. It is agreed that if farm or community level potato storage facility of small to medium capacity be made available could save a significant amount of potato.

A recently completed study (Rabbani et al, 2010) revealed that most of the cold storage space is normally utilized by the potato traders/businessmen; although in some areas, potato growers are the major clients

of cold store. In most of those areas (e.g. Rajshahi, Bogra, Rangpur), the cold storage owners' organized production of potatoes providing credit support; and each of the growers of those organized production, take lease of a large area of land for potato cultivation. The land owners of those areas (mostly small farmers are gradually going out of potato production. This indicates the need of improved potato storage technology at household level. It would not only help save potatoes of small and medium farmers but also empower them in marketing their produce.

Literature search shows that in spite of some study on losses at traditional home storage and cold storage of potato, very limited study to improved potato storage technology at household level has been reported. In 1990s some works have been reported on potato storage. These are discussed in the following paragraphs.

Even today potato farmers store potato at home by stacking them on the earthen floor of dwelling houses or stacking them on bamboo or wooden made platform (*macha*) for better aeration. In the traditional method generally bulk potatoes are stored for three to four months. Heights of bulk storage potato varied from 15 cm to 100 cm. Farmers did not care for height of the pile. They only consider available space and quantity of potato to be stored. During storage period, they frequently checked their home stored potatoes to sort out rotten ones and diseased ones which otherwise would cause damage to the whole quantity of stored potatoes. In this method, farmers cannot maintain proper temperature and humidity. During three to four months of storage period about 7.35% potatoes are lost (Hossain and Miah, 2009). A study on post harvest losses of potato storage system in Bangladesh conducted jointly by National Food Policy Capacity Strengthening Programme (NFPCSP) and BARI strongly recommend that traditional storage system should be improved through research and development so that the farmers can store potato comparatively longer period (4 – 5 months) with lower storing loss (Hossain and Miah, 2009).

Siddique (1994) reported that Crop Diversification Programme (CDP, 1994) developed and promoted a diffused light storage for local variety of potato. It was a bamboo made structure of 4.5' x 3.0' x 5.5' capable of storing about 200 kg of potato on 4-5 separated shelves inside. Natural ventilation and diffused light help increase shelf life of potato up to 2-3 months. It was specially designed for seed potato. This store need to be improved as its performance/efficiency is low in terms of cooling, shelf life and pest attack.

Hossain and Ali (2000) reported that potatoes are sometimes stored specially in Munshigonj potato growing areas in a separate house made of C.I. sheet and bamboo. It could be 5 x10 m sized 45-50 cm above ground and can store 100-150 tons of potato for 3-4 months. It was found less efficient as there is no forced ventilation system. It could be improved by installing solar operated exhaust fan with evaporative cooling system for increased cooling effect so that shelf life of stored potato be increased by at least 4-5 months beyond harvest season.

During 1992-1996 RDA, Bogra constructed six mini-cold storages, each 10 ton capacity for six different vegetables including potato. Based on this study, in 2009, RDA has established another cold storage of 1000 ton capacity (two rooms of each 90'x 40' size) to store seed potato, used for multiplication by tissue culture technology. It is a Freon plant run by electric power of 54 kW, maintain inside temperature 2^{0} C. The cost per kg of potato was about Tk 15/kg of seed potato and is not suitable for farm level use.

Fortunately since early 2000s solar panel has become available in Bangladesh. It has created the opportunity to use it in potato storage structure for forced ventilation through stored potato. However, no study has been reported that uses solar energy for potato storage at farm or community level.

A good progress has been made on storage of potato at community or farm level. In India, Central Potato Research Institute (Ilangantileke *et.al*. 1997) has developed a community level Evaporative Cooled Store (ECS) for potato that could store potato up to 120 days beyond the growing season. It was a bulky, space consuming, costly structure having very inefficient system of natural air ventilation. This ECS has been tested in farmer's community and could save losses up to 80%. In Bangladesh, using the same concept of the technology, a smaller version but different design of the facility could be made and tested at laboratory condition before adapted at farmer's home. Although same concept of the Indian technology be applied here, three new aspects of this study will be, a) simple and easy ECS under a vertical structure to save storage space but increased efficiency, b) application of solar panel for continuous forced ventilation through stored potato would offer increased air flow thereby more cooling effect, and c) designing the structure with low cost material, multipurpose use so that it would be cost effective too. Farmers if accept the technology will be benefited. This research work was aimed to conduct a laboratory research on storage of potato under humid and temperate condition of Bangladesh with a view to prescribe a suitable technology for small farm household.

8. Sub-project Objectives:

a) General : To reduce storage loss of potato at household level.

b) Specific Purpose:

i) To develop and test an improved evaporative cooled potato store for farm household

ii) To identify the optimum storage design structure using data analysis and modeling

9. Methodology Followed:

Description of the Improved Storage Bin for Experimentation.

Evaporative Cooling System (ECS) store is a small store house where potato could be stored in bulk on a raised platform inside an insulated closed structure. Improved ECS was constructed using locally available material such as cement, sand and M.S. rod. Reinforced cement concrete and bricks were used to build the evaporative chamber having 2.0 m diameter and 0.5 m depth at the bottom of the store. At least half of the chamber holds water all the time so that rest of the brick block (having water socking properties) at upper portion can get wet by capillary action. Water was poured in to the evaporative chamber time to time to maintain a constant level of water (Pic. 1). An outside transparent plastic tube indicated the required level of water. A forced air ventilation by a rotary exhaust fan, powered by solar panel, located at the top of the storage bin helped accelerate evaporate water from the evaporative chamber kept below the storage bin. Cool and moist air flow helped maintain the inside storage temperature below the air temperature inside the bin. Two exhaust fans (each 300 mm dia), placed on the top of the storage bin and powered by three solar panels, forced the inside air out so that the potato enjoyed fresh air/oxygen from outside the bin. These exhaust fans generated an airflow rate of 0.6 $m^3/m^2/sec$ and was operational only during 6-7 hours day time. The entire potato storage bin was installed inside a newly built Post-harvest Preservation and Processing Laboratory of the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh (Pic. 2 & Pic. 3). The design drawing of the experimental storage structure is shown in Annex-A

Pic. 1 Evaporative cooling chamber at bottom of the improved storage bin

Pic. 2 The improved potato store for experimentation

Pic. 3 The project was monitored by a BARC representative

Pic. 4 Equivalent Farmer's Traditional Storage (Farmer's Practice) under investigation in the same laboratory

Selected Varieties of Potato for the Experiment:

Two potato varieties (Lal pakri and Diamant) in two different sizes (small and large), purchased from local market of Nunuz Bazar, Kalai upozilla of Joypurhat district were stored inside the bin on 25 March 2013. Before loading into the bin the potatoes were sorted, removed immature potatoes and allowed several days for curing. Potatoes were stored in four different shelves. Each shelf contained four categories of potatoes (Lal Pakri-small, Lal Pakri-large, Diamant-small and Diamant-large). All potatoes were stored in nylon netted sack of 10 kg each. In addition, ten small nylon netted sack of one kg potato from each category was placed in each shelf for determination of moisture content, vitamin C, and total sugar.

Equivalent Farmers' Traditional Storage (here after called Farmer's Practice) was also maintained inside the laboratory with the same categories of the potato (Pic. 4). The same four categories of potato were stored in this method with Lal Pakri-small (120 kg), Lal Pakri-large (85 kg), Diamant-small (110 kg) and Diamant-large (115 kg).

Design of Experiment:

The principle of Completely Randomized Block Design **(**CRBD) with 3 factors, 4 replications was considered for experimentation. There were eight treatment combinations (2 x 2 x 2 = 8) as follows

Factor A (Storage condition – 2 levels) : (a) Improved storage (b) Farmer's traditional storage
Factor B (Varieties of potato – 2 levels) : (a) Diamant (b) Lal Pakri
Factor C (Size of tubers – 2 levels) : (a) Large (b) Small

Sixty kg (in 6 bags) potatoes of each of (a) Diamant Large (about 100 gm/tuber), (b) Diamant Small (about 51 gm/tuber), (c) Lal Pakri Large (about 23 gm/tuber) and (d) Lal Pakri Small (11 gm/tuber) were loaded on all the 4 shelves of the Improved Storage Bin as per loading pattern shown in Fig. 1. In total, 960 kg potatoes were loaded into the Improved Storage Bin for experimentation.

For the Equivalent Farmers' Traditional Storage (Farmer's Practice) 115 kg of Diamant Large, 110 kg of Diamant Small, 85 kg of Lal Pakri Large and 120 kg of Lal Pakri Small potatoes were kept on C.C. floor (over a bamboo mat with a thin layer of dry sand) inside the same room in which the Improved Storage bin was located. Potato samples were taken from both the storage conditions 15 days interval on the same day of sample collection.

Experimentation:

The experimental data collection was started on 1st April 2013 and continued up to November 2013. Air temperature above four shelves (inside the bin) and the temperature of potato at sixteen points were recorded by a data logger and LabView software. Air flow through the bin, relative humidity of air inside the bin, and ambient air temperature were measured. Sample potato was taken at 15 days interval from 16 different cells of the shelves to find out the spoilage, sprout, moisture content, vitamin C, and total sugar content. The collected data were analysed for meaningful interpretation and model development. Subsequently, an optimum potato storage design for farm household has been reported.

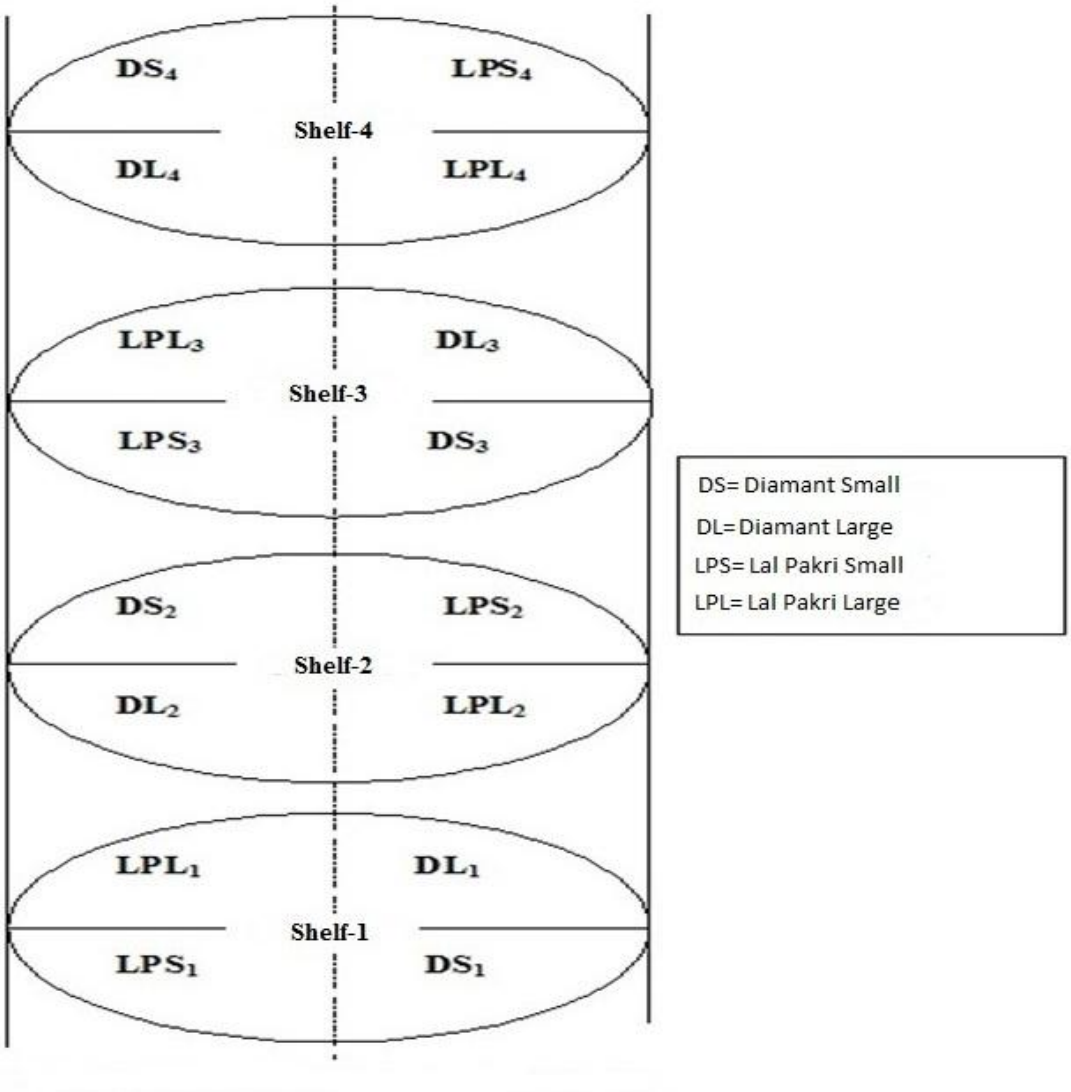

Fig. 1 Loading pattern of potato inside the Improved Storage Bin

Determination of Mean Weight of Potato:

Two hundred potatoes from each size group of each variety were taken randomly and were weighted. The average weight of the potato for a particular size of the particular variety was calculated dividing the total weight by 200. Thus, mean weight per tuber of each category was determined.

Determination of Potato Spoilage:

Number of potato spoiled (i.e. unacceptable due to rotten) was recorded by observation method at 15 days interval for all categories and population of potato kept in the sacks. The amount (by weight) of spoiled potato was calculated multiplying the number of spoiled potato found by the mean weight per potato tuber. Similarly, same method was followed to determine the spoilage found in farmer's traditional practice. Thus, monthly spoilage of potato was obtained for both the storage methods.

Determination of Nutritional Parameters:

Vitamin-C content:

Vitamin-C (Ascorbic Acid) content of potato samples taken fifteen days interval from four different shelves of the experimental storage bin as well as from farmer's practice was determined by Titration method. All the required chemicals including the dye (2,6-Dichlorophenol indophenol) was prepared at the very beginning. The dye was standardized. After that required amount of potato sample was taken and made volume by Meta phosphoric acid (HPO_3). 1 ml 40% formaldehyde and 0.1 ml HCl were added. This was titrated with the standard dye to a light pink color (end point), which persisted for 10-15 seconds.

Total Sugar Content:

The total sugar content of potato sample taken fifteen days interval from four different shelves of the Improved Storage Bin as well as farmer's traditional practice was determined by the LANE & ENYON method. The sugar content was estimated by determining the volume of the unknown sugar solution required to completely reduce a measured volume of Fehling's solution. All the required reagents were prepared following the standardization procedure of the Fehling's solution. Then the sample was prepared. The amount of reducing sugar was determined by titration against Fehling's solution A & B when brick red color was obtained. Finally, the total sugar was determined by titration against Fehling's solution A & B.

Moisture content:

The moisture content (wet basis) of the potato sample taken fifteen days interval from four different shelves of the Improved Storage Bin as well as farmer's practice was determined by the oven dry method. Empty weight of crucible and the weight of the potato sample were determined. Then the crucible with sample was placed in an air oven and dried at a temperature of 100 to 105^0C for 24 hours. After drying, the crucible was removed from the oven and placed inside a desiccator. It was weighted again. From these weights, the moisture content of each potato sample was calculated.

Sprouting:

The method of observation and measurement of length of sprouts were considered in estimating the percent of potato sprouted in each sack kept in four shelves of the storage bin as well as potato from farmer's traditional store. It was observed at an interval of fifteen days when potato samples was taken for determination of other parameters mentioned above.

Shrinkage:

The shrinkage of potato by volume was estimated by observation method and scaled using Likert scale (0-5) of quality assessment. Zero (0) and (5) indicates 0% and 50% shrinkage by volume, respectively.

Economic Benefit:

Ignoring the fixed cost of the facilities, calculation of the gross economic benefit using improved storage bin may be calculated using the following model. The model determines the relative savings of potato from loss in the Improved Storage Bin over farmer's traditional storage.

$$B = p*[(ps - plsp*ldsp - plsk*ldsk)] \quad \text{..... (1)}$$

where

B = Gross benefit in the Improved Storage Bin over farmer's storage in any month, Tk/kg

p = Unit market price of potato, Tk/kg

ps = Percent of potato saved

plsp = Price loss factor for sprouting, fraction

ldsp = Percent loss difference due to sprouting

plsk = Price loss factor for shrinkage, fraction

ldsk = Percent loss difference due to shrinkage

Optimum Duration of Storage :

The optimum duration of potato stored in the Improved Storage Bin may be determined by the time unit (month) when the economic benefit (B) become maximum. Mathematically, it could be obtained by taking first derivative of the benefit equation (1) and equating to zero value. That is

$$d(B)/d(t) = p*[(ps - plsp *ldsp - plsk * ldsk)] = 0 \quad \text{.....(2)}$$

Graphically, it may be obtained by plotting the equation (1) in an ordinary graph paper.

Optimum size of the Improved Storage Bin for Farm Household:

Based on the data analysis and economic benefit, an optimum size of the improved potato storage bin was obtained use of method of dimension proportionality and ease of fabrication.

10. Results and Discussion (Analysis of the information /data supported by tables, result & discussions, research achievements, highlights and photos):

Determination of Potato Spoilage:

Potato spoilage was determined monthly following the procedure as mentioned in the methodology section are shown in Fig. 2 to Fig. 5, for four categories of potato. The figures indicate that the average spoilage of all four categories of potatoes in the Improved Storage Bin was 20.06% lower than that of Farmer's Traditional Practice. On the other hand, the figures also show that the spoilage rate was also higher in Farmer's Practice than that of Improved Storage Bin. The quality in terms of physical appearance of potatoes (before and after experimentation) found better in the Improved Storage Bin than that of Farmer's Practice (Pic. 5). No difference of spoilage of potatoes was found between the shelves of the Improved Storage Bin. The Evaporative Cooling Chamber at the bottom of the Improved Storage Bin positively contributed in cooling the potato as well as maintaining the required humidity inside the bin. As a result the spoilage and the shrinkage of potato were found 20.06% and 25.00% less, respectively, in the Improved Storage Bin than that of farmer's practice. Annex – B shows the pattern of potato temperature and air temperature inside the Improved Storage Bin. It reveals that insufficient cooling (i.e. difference of air temperature and potato temperature) of potato occurred in the middle portion of the Improved Storage Bin with compare to bottom and top shelves. This indicated that an exhaust fan needs to be installed in the middle of the bin but on the side wall of the bin for better ventilation and cooling of potatoes of the middle shelves. This has been proposed in the optimum design for farmer's version of the improved storage.

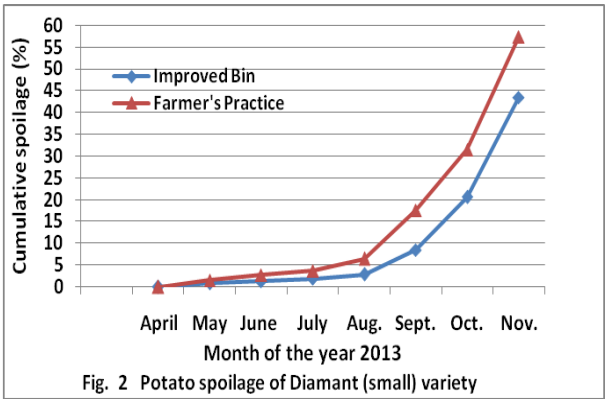

Fig. 2 Potato spoilage of Diamant (small) variety

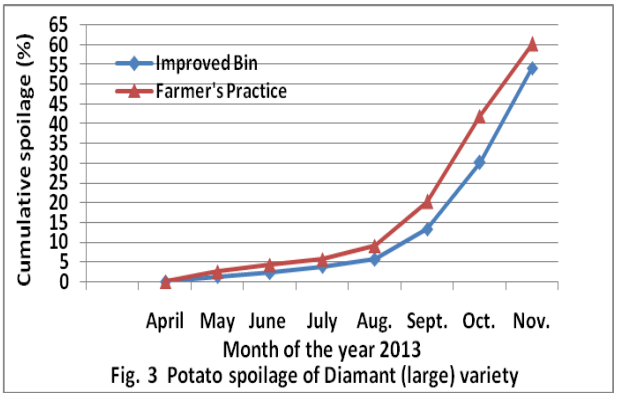

Fig. 3 Potato spoilage of Diamant (large) variety

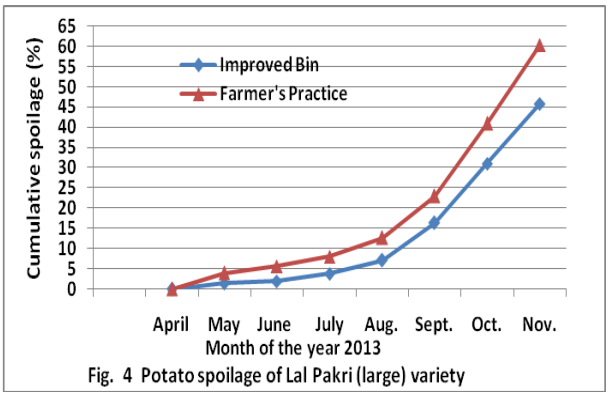

Fig. 4 Potato spoilage of Lal Pakri (large) variety

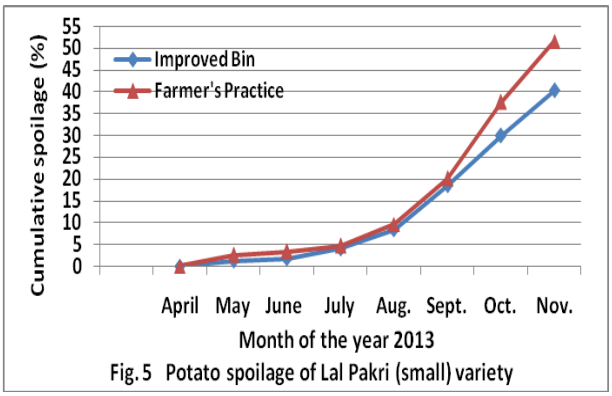

Fig. 5 Potato spoilage of Lal Pakri (small) variety

Determination of Nutritional Parameters:

Vitamin C content of the stored potato decreased with the increase of time. Fig. 6 and Fig. 7 show that the level of vitamin C content was found 6.99 % and 2.58% higher in Diamant and Lal Pakri varieties, respectively, stored in the Improved Storage Bin than that of farmer's practice. However, the level of vitamin C content was 4.41% higher in the Diamant variety than that of Lal Pakri variety. It may be concluded that the Improved Storage Bin could help maintain higher level of vitamin C than that of farmer's practice.

Fig. 8 and Fig. 9 indicates that there was no significant differences of total sugar content of the potato stored in both the storage under investigation. However, total sugar content of Diamant variety found slightly higher in case of farmer's practice for stored period beyond September (Fig. 8). In case of Lal Pakri, there was no difference of total sugar content between its sizes as well as the method of storing (Fig. 9).

Determination of Moisture Content

The average moisture content as measured in the beginning of storing of potato was about 80 percent for both the categories. Table C3 indicates that the rate of moisture loss from both size of Diamant varieties of potato was found to 0.32 % per month. However, the rate of moisture loss from both sizes of Lal Pakri variety was found to 0.38 % per month (Table C4). It reveals the fact that the rate of moisture loss is higher than that of Diamant variety. This was happened due to higher total surface area of Lal Pakri variety than that of Diamant variety. Very similar results were also observed in Farmer's Practice.

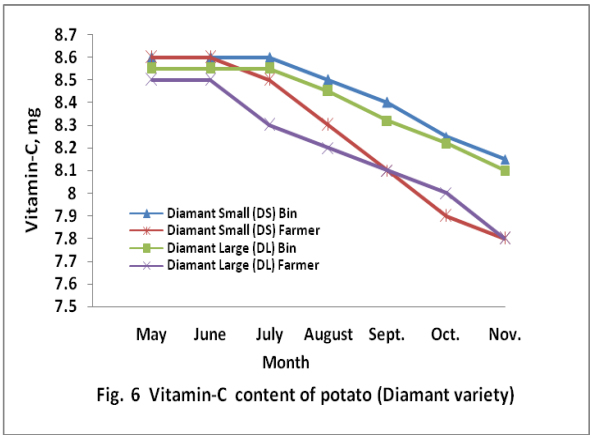

Fig. 6 Vitamin-C content of potato (Diamant variety)

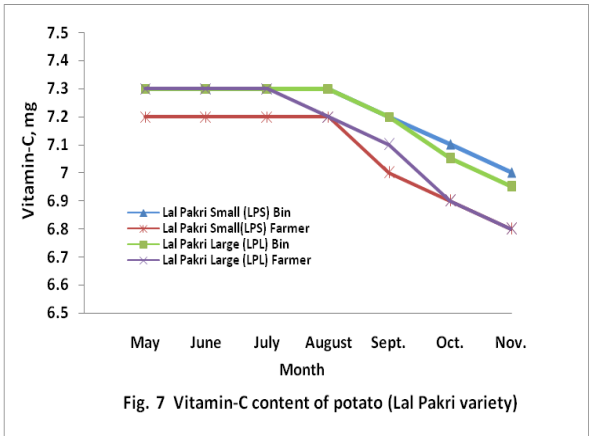

Fig. 7 Vitamin-C content of potato (Lal Pakri variety)

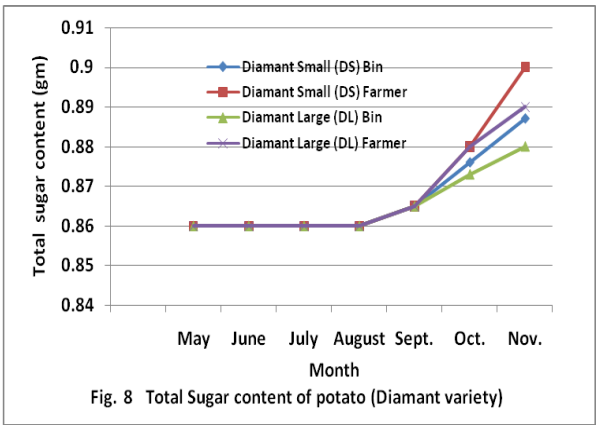

Fig. 8 Total Sugar content of potato (Diamant variety)

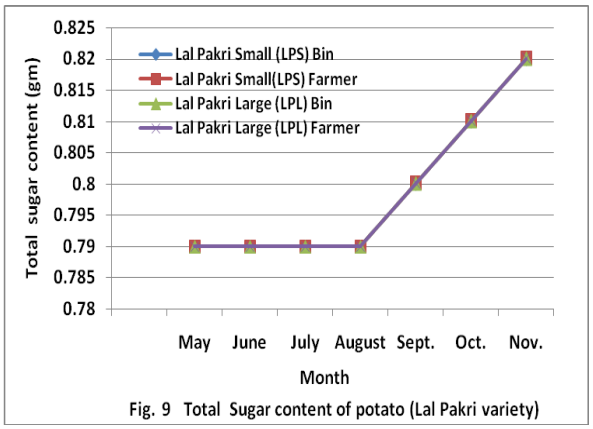

Fig. 9 Total Sugar content of potato (Lal Pakri variety)

<table>
<tr><td colspan="2">Before experimentation
(on 25 March 2013)</td><td>Method of storage</td><td colspan="2">After experimentation
(on 30 November 2013)</td></tr>
<tr><td rowspan="2"> 
Diamant (small)</td><td rowspan="2"> 
Diamant (large)</td><td rowspan="2">Improved storage bin</td><td> 
Diamant (small, S-3)</td><td> 
Diamant (large, S-2)</td></tr>
<tr><td> 
Lal Parki (small, S-3)</td><td> 
Lal Pakri (large, S-4)</td></tr>
<tr><td rowspan="2"> 
Lal Pakri (small)</td><td rowspan="2"> 
Lal Pakri (large)</td><td rowspan="2">Equivalent Farmer’s Traditional Storage (Farmer’s Practice)</td><td> 
Diamant (small)</td><td> 
Diamant (large)</td></tr>
<tr><td> 
Lal Pakri (small)</td><td> 
Lal Pakri (large)</td></tr>
</table>

Pic. 5 Quality of stored potato in both the methods as reflected by pictures

Sprouting and Shrinkage:

Sprouting was the common phenomenon of stored potato in both the method of storage. Sprouting of potato started after four months of storing but growth stopped after six months in both the method. Sprouting of a potato was considered here for its growth 10 mm and above. The percent of potato sprouted was calculated by counting method. Fig. 11 represents the growth of sprout. It indicates that the percent of sprouting was 8.57% lower for Diamant variety in the Improved Storage Bin than that of farmer’s practice. Sprouting was found lowest (6.66%) in case of Lal Pakri stored in the Improved

Storage bin. That means Improved Storage Bin performed better regarding control of sprouting. It may be mentioned here that no control measure for sprouting was undertaken in both the storage methods.

Shrinkage is another phenomenon of natural potato stores. It was estimated by the volume decreased in a particular time of sample collection and was recorded by observation method. Fig. 12 shows the percent of shrinkage of potato over time. Shrinkage increased with increase of time. It was observed after six months of storing (i.e. beyond September), it was 25% higher in case of farmer's practice than that of improved bin. It revealed that shrinkage of potato was lower in the Improved Storage Bin than that of farmer's practice. Again, it may be conclude that the Improved Storage Bin performed better than that of farmer's traditional practice.

Economic Benefit:

The economic benefit depends mainly on market price of potato. If the price of potato increases significantly with time of storage then the Improved Storage Bin will be more beneficial and attractive to the potato farmers and traders. In 2013, the increase of market price of potato beyond harvest season was not significant with compare to last couple of years. The price trend of potato is graphically presented in Fig. 10. This price trend was used to calculate the gross benefit of use of Improved Storage Bin over farmer's traditional practice. Gross benefit decreases with increased rate of sprouting and shrinkage. The price loss due to sprouting and shrinkage considered here were 10% and 80%, respectively. Ignoring fixed cost of the storage methods, the gross benefit of using improved storage bin over farmer's practice was calculated using equation no. 1 mentioned above and is presented in Fig. 13. Fixed cost has been ignored here because the laboratory version of the storage structure cannot be compared with Farmer's Practice until a farmer version is available. Therefore, only the variable costs were considered. It reveals that the maximum gross benefit of storing Diamant variety using improved storage bin found in the month of October. Beyond October the gross benefit started decreasing due to price loss for higher level of shrinkage and/or sprouting. In other words, Diamant variety could be stored up to seven months after harvest. On the other hand, Lal Pakri could be stored in the improved storage bin for longer period with higher profit. This was mainly due to higher market price of Lal Pakri than that of diamant variety. Fig. 13 indicates that Lal Pakri would bring gross profit by Tk. 2.57 per kg.(calculated using market price of November 2013) over Farmer's Practice, if stored upto November. On the other hand, Diamant variety would bring gross profit by Tk. 1.34 per kg over Farmer's Practice, if stored up to November. The gross return of total potato stored in the improved bin is shown in Annex-D.

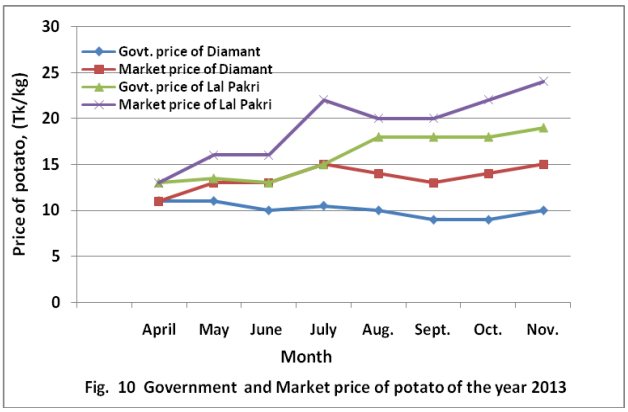

Fig. 10 Government and Market price of potato of the year 2013

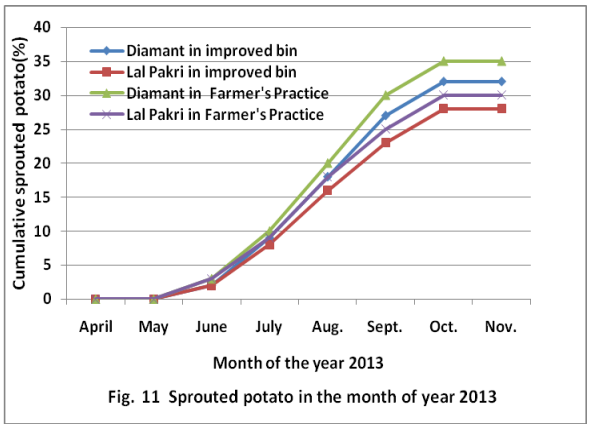

Fig. 11 Sprouted potato in the month of year 2013

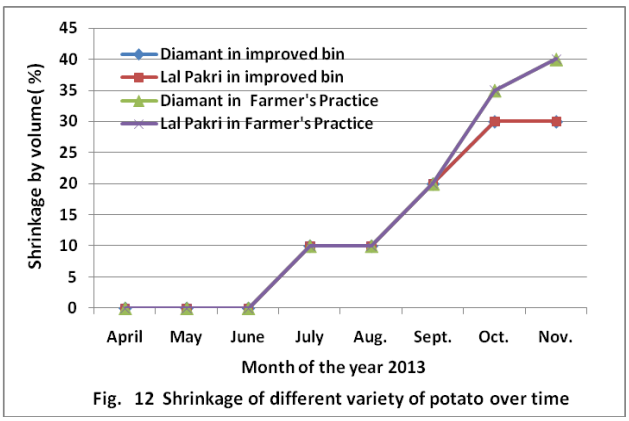

Fig. 12 Shrinkage of different variety of potato over time

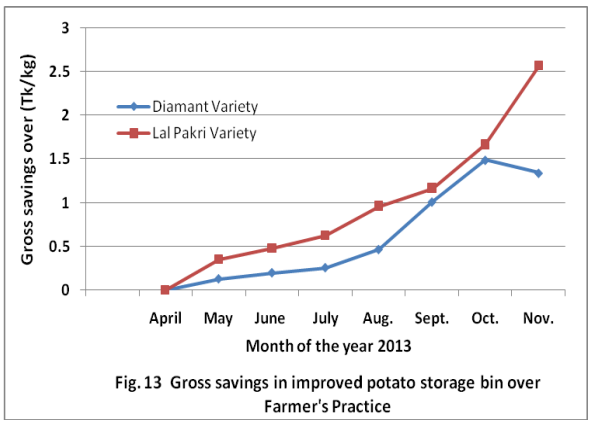

Fig. 13 Gross savings in improved potato storage bin over Farmer's Practice

Optimum Size of the Improved Storage Bin for Farm Household:

Fig. 14 shows the optimum improved storage bin for small farm household with a capacity of 500 kg of potato. For higher storage capacity (upto 1500 kg), the store size would be proportionally bigger (only horizontally but not vertically) but not more than three times larger. Two exhaust fans having 300mm dia each will be required to force inside air out of the storage. A set of earthen jar filled with water will help cool the stored potato and maintain air humidity above 75%. Potatoes could be shelved in five shelves of the bin at a depth not more than 100 mm. A solar system with a capacity of 200 watt will be sufficient to power the fan. The fan may be operated for 6-7 hours day time. The solar system could also be used for power supply to farm house at night for better utilization and economy of the system. The total cost (year 2014) of the improved storage bin, including solar system and exhaust fan, for a capacity of 1500 kg has been estimated to Tk. 38,000.00 with an expected life of 10 years.

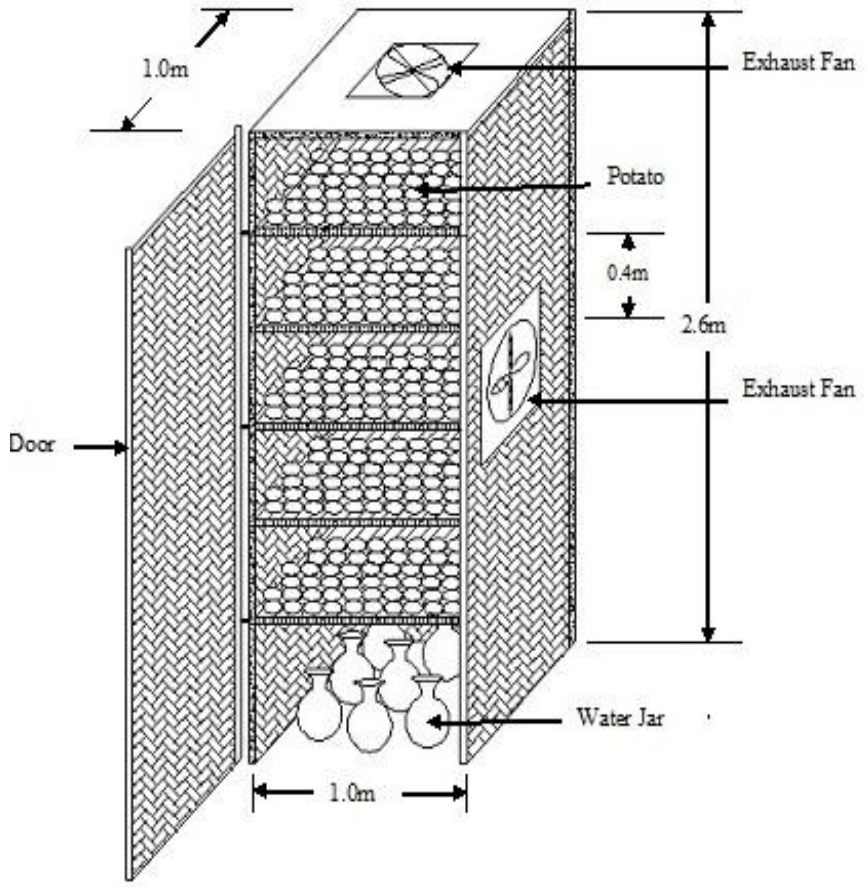

Fig. 14 The proposed design of Improved Storage Bin for small farm household

Discussions:

The experiment was conducted under rodent and insect free environment. The water level inside the evaporative cooling chamber of the bin was maintained at a constant level. To maintain the water quality up to its original state a small quantity of alum and potash per manganese were added several time to keep the water free from pathogen or bacteria growth.

Exhaust fans was kept operational only in the day time although there was a series of rechargeable battery to power the exhaust fans at night. This strategy was undertaken for two reasons i.e. to conserve energy and to keep the potatoes free from excessive moisture loss.

It was observed that during monsoon season solar system sometimes failed to power the exhaust fan in a continuous mode even during day time. In other words discontinuous power supply occurred. But it happened only couple of times throughout the monsoon period. However it did not affect the results

11. Research Highlights (bullet points- max 10 nos.)

a. The improved storage bin performed better than the farmer's traditional practice.
b. The improved storage bin may bring benefit for both Diamant and Lal Pakri varieties but higher gross benefit and longer safe storage for Lal Pakri variety.
c. An optimum design for small scale storage has been proposed but needs validation at farmers/growers household before commercialization of the technology
d. A set of scientific data has been generated for further research and modelling.
e. A new permanent research facility (post-harvest preservation and processing Lab) developed in the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh for future Ph.D. level research

12. Major Attainments (in relation to the set objectives)**:**

a. Technical : Output, Outcome and Impact

Objective	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)	Impact (long term effect of the research)	Remarks (reason, if anything otherwise plus any other)
To develop and test an improved evaporative cooled potato store for farm household	1) Design and construction of an improved potato storage bin 2) Instrumentation done 3) Data collection performed	1) Laboratory version of improved potato storage bin 2) Data logger & other instruments	- New knowledge generated - Physical facility created	Contributed in the scientific field with new knowledge	
To identify the optimum storage design structure using data analysis and modeling	1) Data analysed and interpretation 2) Improved storage design for farm household proposed	1) A set of experimental data collected for future use (Annex-C) 2) An improved design of storage bin available 3) A new laboratory established	- New knowledge generated - Physical facility created - Two M.S. thesis prepared	Farmers' will be benefitted economicall y using the improved technology, thereby reduced loss of potato .	

b. Procurement

Sl. No	Approved provisions of procurement (list of major items)	Achievements	% of achievements	Remarks (statement on the handing over of the materials procured/developed as per LOA plus any other)
1	Small Transport (bi-cycle)	done	100	To be handed over soon after completion of the sub-project.
2	Equipment for experimentation (Data logger and its LabView software, one lap top, camera, solar panel systems, exhaust fan, electric blower, two battery, thermometer, hygrometer, and anemometer)	done	100	To be handed over soon after completion of the sub-project.
3	Procurement of bulk potato for experimentation	done	100	1800 kg of potato; two varieties procured from Joypurhat
4	Construction of Storage structure including its shed	done	100	To be handed over soon after completion of the sub-project.
5	Appointment of consultant	done	100	Prof. Dr. Abdus Siddique joined as an expert consultant on 14 June '12

c. HRD/Training

Title (e.g. Ph.D/MS/Trainings,workshops conducted etc.)	Target	Attainments	No/Name. of participants	Benefit of the higher studies/trainings (application of the learning, productivity enhancement)	Remarks (reason, if anything otherwise)
M.S. degree in Farm Power & Machinery	Dec '13	Dec. '13	Md. Monirul Islam Reg. 34544	Obtain M.S. degree in Farm Power & Machinery	Graduation in Dec. 2013
Annual Workshop	Dec. '12	20 May '13	40	Knowledge shared and learned about storage of potato	Experts from BAU, BARC, RDA, BARI, BSMRAU, NGO
Training conducted for M.S. students of the Faculty of Agril. Engg at BAU	Dec. '13	23 Dec'13	65	Learned about research design, data recording data logger & software; data analysis & presentation of results	
Annual Workshop	Dec. '13	26 Dec '13	60	Knowledge shared and learned about storage of potato and the achievements from the research	Experts from BAU, BARC, RDA, BARI, BSMRAU, NGO

d. Financial

Sl. No	Major Head	Fund received (Tk.)	Expenditure (Tk.)	Balance/Unspent (Tk.)	Remarks (reason, if anything otherwise)
1	GoB	172464.00	150888.00	21576.00	Balance will be zero by 31 Dec.'13
2	RPA	3276836.00	2881494.00	395342.00	
	Total	3449300.00	3032382.00	416918.00	Balance Expenditure committed

e. Materials developed/Publications made

Sl. No	Type of material/publication	Title	Number	Remarks (being used by/meant for/any other)
1	Technology development	A new technology on potato storage bin has been developed for farm household	one	
2	Process development/Physical facility developed	A new permanent research facility (post-harvest preservation and processing Lab) developed for future Ph.D. level research	one	
3	Information development	A set of valuable scientific data have been generated for future reference/ research work	one set	
4	Journal Publication			To be done later
5	Books/Monographs/Manual published			To be done soon
6	Booklet/leaflet/flyer etc. published			
7	Any other (M.S. theses/patent/etc)		two	one thesis completed other under preparation

13. Sub-project Auditing (cover all types of auditing performed)

Types of Audit	Major observations/issues/objections raised, if any	Date(s) of audit	Remarks (Activities performed/ modification suggested)
Financial Audit	No objection made	04 October 2012	
BARC (Dr. Abu Taher)	Site visited and good discussion made	10 December, 2012	
M & E by SPGR/BARC (Dr. Anwer Iqbal & his Internal Consultant)	Meeting held in BAURES office; discussion on project progress	20 January 2013	
BARC (Dr. Abu Kalam Azad and his team members)	Site visit and fruitful discussions	19 February 2013	
BARC (Dr. Ahmad Ali Hassan, MD)	Couple of suggestion offered on storage bin	7 April 2013	

BARC (Dr. Abu Taher)	Site visited and good discussion made	16 April, 2013	
BARC (Dr. Ahmad Ali Hassan, MD); BAU and Annual Workshop participants	Offered valuable suggestions and comments. Most of their suggestions were incorporated in the research work	20 May 2013	Annual workshop held. 40 experts from BAU, BARC, RDA, BARI, BSMRAU, NGO participated
BAU (BAURES)-Annual Workshop	Couple of suggestions were offered & incorporated	5 October 2013	A paper was presented
BARC (Dr. Ahmad Ali Hassan, MD)	Suggestions were offered on preparation of project completion report	13 October 2013	
Financial Audit by GoB	No objection made	10 November 2013	
Financial Audit by J U Ahmed & Co.	No objection made	28 November 2013	

14. Reporting

Report type	Actual date of submission	Total Number(s)	Remarks
a. Inception report		1	
b. Monthly reports*	11 March 13; 11 April '13, 18 June '13, 10 July '13	2	
c. Statement of expdts.(SoE)*	11 March 13; 11 April '13, 18 June '13, 10 July '13	23	
d. Quarterly report(s)*	12 July '13	8	
e. Six monthly report	30 Sept '13	4	
f. Procurement plan	March '12 & August '13	2	
g. Annual research program format			Not applicable
h. Environmental monitoring (annual Basis)			
i. Social safeguard status (Before and at the end)			
j. Field Monitoring report(s)**	January 13 and February 13		

** Provide all the dates by month and quarter since start to date.*

*** Conducted at the local level by implementing agencies. To be submitted by quarter.*

15. Problems/ Constraints (bullet points-max 5 nos.):

a. Lengthy tendering/bidding made the project work delayed by about two months.

b. Purchase of data logger and its software (LabView) took longer time as it was not available in local market.

16. Suggestions for Future, if any:

a. Experimentation should have continued up to one year for better results and conclusion

b. The optimum design as obtained from laboratory experimentation must be validated in farmers' household before commercialization of the proposed technology. This validation could be done by undertaking the 2nd phase of the research work.

c. The technology may be tested for multi-purpose use with similar crops so that it could be more profitable and attractive to farmers.

d. The solar system of the improved storage bin could be used for 6-7 hours in day time and remaining 5-6 hours for supply of electric power to farm house at night.

17. References

1) Ahmad, K. U. 1981. Potato Research in Bangladesh. Potato Research Centre, BARI, Joydebpur
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5) Eltawil, M. A., D.V.K. Samuel and O.P. Singhal. 2006. Potato storage technology and store design aspects. Agricultural Engineering International. The CIGR Ejournal 8(11): 1-18.
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9) Ilangantileke, S.G.. Khatana, V.S., Singh, J.P. and Kumar, D. (1997) Improved Rustic Storage in South Asia, Central Potato Research Institute (CPRI), Modhipuram, India
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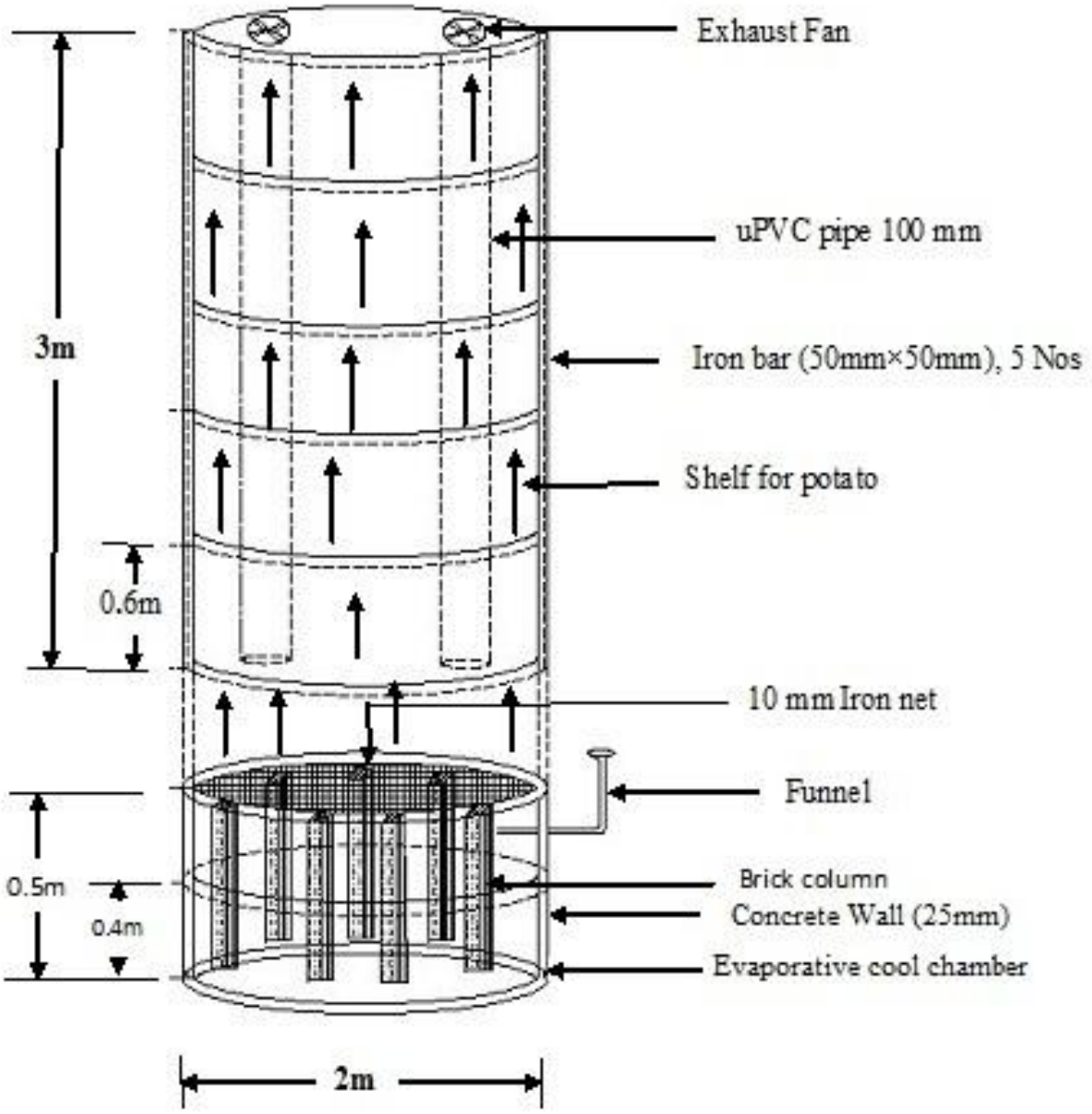
12) Siddique, M.A. and M. H. Rashid. 1999. Role of true potato seed in potato development. Proc. Workshop on Potato Development in Bangladesh. ATDP/IFDC, Dhaka. pp 43-48.
13) UIE (2009) Options for Storing Potatoes at Home; University of Idaho Extension, Idaho, USA
14) Yasmin, S. 2006. Effects of pre- and post-harvest management on the quality of true potato seed. Ph.D. dissertation, Deptt. of Horticulture, BAU, Mymensingh.

Signature of the Coordinator/Principal Investigator Date: Seal	Counter signature of the Head of the agency/authorized representative Date: Seal

Annex-A

The design drawing of the improved potato storage bin for experimentation



Annex-B

The potato temperature and air temperature inside the Improved Storage Bin in different months

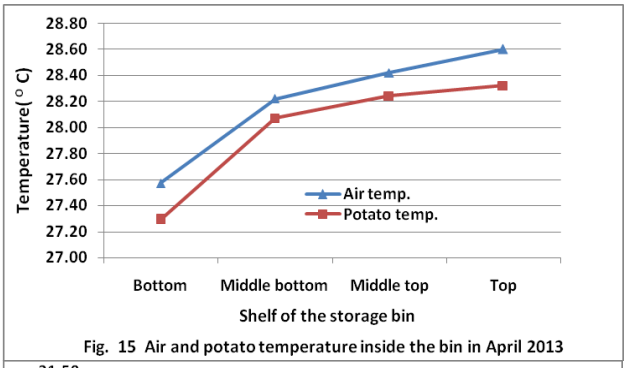


Fig. 15 Air and potato temperature inside the bin in April 2013

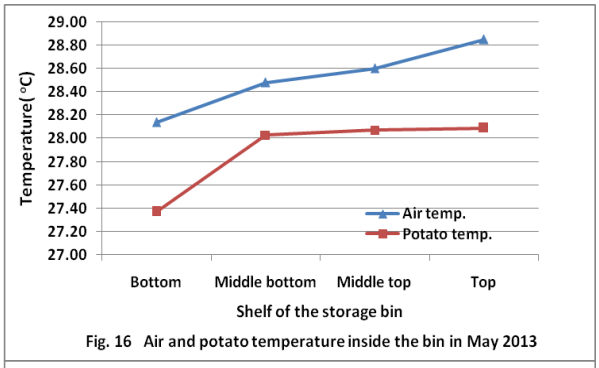


Fig. 16 Air and potato temperature inside the bin in May 2013

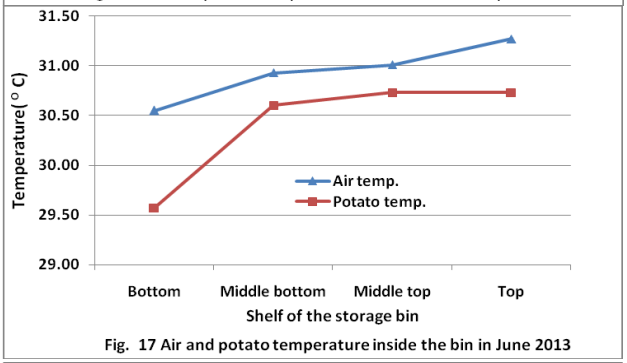


Fig. 17 Air and potato temperature inside the bin in June 2013

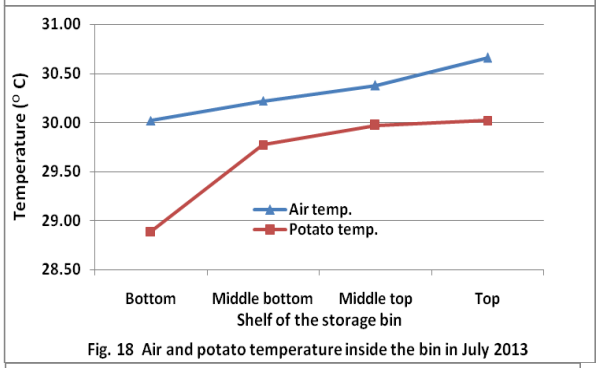


Fig. 18 Air and potato temperature inside the bin in July 2013

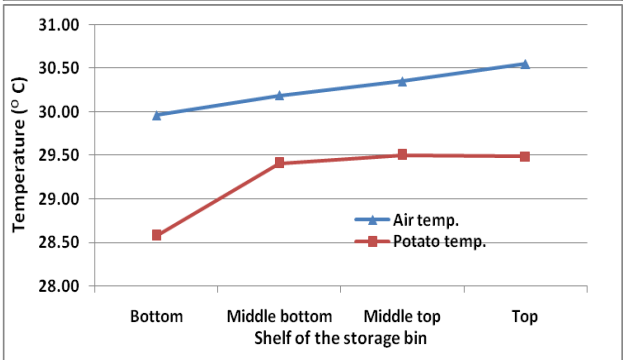


Fig. 19 Air and potato temperature inside the bin in Aug. 2013

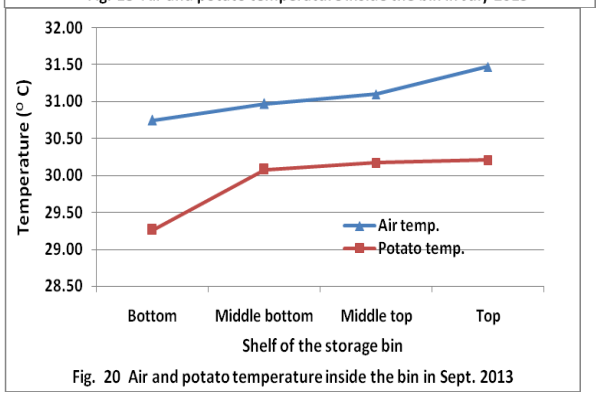


Fig. 20 Air and potato temperature inside the bin in Sept. 2013

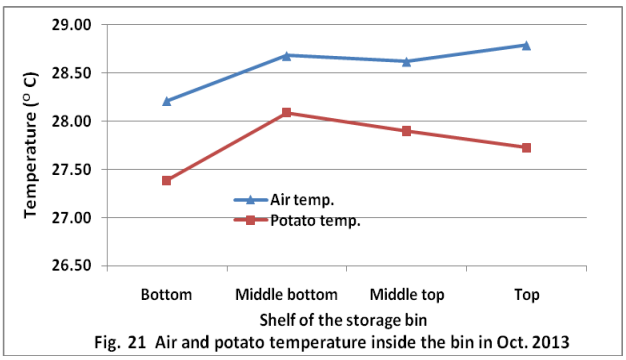


Fig. 21 Air and potato temperature inside the bin in Oct. 2013

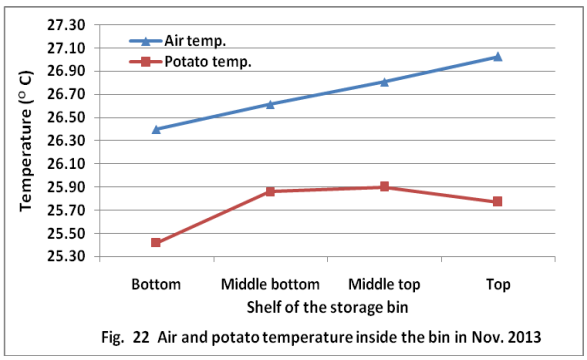


Fig. 22 Air and potato temperature inside the bin in Nov. 2013

Annex-C

Table C1. Cumulative potato spoilage in different months inside the improved storage bin and in farmer's practice

Variety of Potato	Amount stored, kg	Type of store	April 2013		May 2013		June 2013		July 2013		August 2013		September 2013		October 2013		November 2013	
			spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)
Diamant Small (DS)	240	Improved Bin			2.00	0.83	3.13	1.30	4.62	1.92	6.87	2.86	20.27	8.44	49.25	20.52	104.24	43.43
	110	Farmer			1.64	1.49	2.92	2.65	4.10	3.72	7.08	6.43	19.29	17.53	34.59	31.44	63.19	57.44
Diamant Large (DL)	240	Improved Bin			3.03	1.26	5.65	2.35	9.38	3.90	13.61	5.67	31.96	13.31	72.32	30.13	129.97	54.15
	115	Farmer	`		2.92	2.54	4.84	4.21	6.55	5.69	10.48	9.11	23.38	20.33	48.15	41.87	69.22	60.19
Lal Pakri Small (LPS)	240	Improved Bin			2.65	1.10	3.94	1.64	9.53	3.97	20.02	8.34	44.10	18.37	71.70	29.87	96.65	40.27
	120	Farmer			3.02	2.52	3.98	3.32	5.47	4.56	11.48	9.57	23.98	19.98	45.07	37.56	61.77	51.47
Lal Pakri Large (LPL)	240	Improved Bin			3.50	1.45	4.74	1.97	9.27	3.86	17.16	7.15	39.25	16.35	74.62	31.09	110.01	45.83
	85	Farmer			3.43	4.03	4.90	5.76	6.89	8.10	10.79	12.69	19.57	23.02	34.80	40.94	51.29	60.34

Table C2. Cumulative potato spoilage in different months and shelves inside the storage bin

	Cumulative potato spoilage																	
Shelf Number	Amount stored, kg	April 2013		May 2013		June 2013		July 2013		August 2013		September 2013		October 2013		November 2013	
		spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)	spoilage (kg)	spoilage (%)
1(bottom)	240			2.81	1.17	5.45	2.27	9.76	4.07	13.51	5.63	31.41	13.09	78.20	32.58	129.83	54.10
2(bottom middle)	240			2.30	0.96	3.97	1.65	7.62	3.18	14.91	6.21	35.66	14.86	84.50	35.21	123.87	51.61

3(top middle)	240			3.08	1.28	3.87	1.61	7.25	3.02	14.44	6.02	34.50	14.38	83.54	34.81	122.44	51.02
4 (top)	240	`		2.98	1.24	4.14	1.73	8.13	3.39	14.77	6.15	34.03	14.18	82.42	34.34	123.51	51.46

Table C3. Moisture content (wb %) of potato determined by oven method

Potato Variety	Type of storage	May-13	June-13	July-13	Aug-13	Sep-13	Oct-13	Nov-13
Diamont Small (DS)	Improved bin	79.92	79.903	79.815	79.576	79.248	78.848	78.377
	Farmer Practice	80.805	80.805	80.695	80.435	80.09	79.615	79.24
Diamont Large (DL)	Improved bin	79.98	79.973	79.905	79.657	79.355	78.965	78.53
	Farmer Practice	79.85	79.565	79.47	79.22	78.7	78.235	77.85
Lal Pakri Small (LPS)	Improved bin	77.85	77.62	77.23	77.081	76.751	76.416	75.982
	Farmer Practice	77.55	77.155	77.04	76.685	76.035	75.575	75.15
Lal Pakri Large (LPL)	Improved bin	77.72	76.918	76.832	76.641	76.361	75.986	75.54
	Farmer Practice	77.78	77.35	77.355	77.01	76.6	76.125	75.77

Table C4. Moisture content (wb %) of potato determined by oven method in different shelf

Shelf No.	May-13	June-13	July-13	Aug-13	Sep-13	Oct-13	Nov-13
1 (bottom)	79.00	78.66	78.58	78.38	78.04	77.62	77.16
2 (middle bottom)	78.50	78.30	78.22	78.02	77.77	77.44	77.00
3 (middle top)	78.92	78.72	78.63	78.47	78.13	77.77	77.29
4 (top)	78.50	78.43	78.32	78.10	77.76	77.39	76.98

Table C5. Vitamin-C content of potato (mg) determined by Titration method

Potato Variety	Type of storage	May-13	June-13	July-13	Aug-13	Sep-13	Oct-13	Nov-13
Diamant Small (DS)	Improved bin	8.600	8.600	8.600	8.500	8.400	8.250	8.150
	Farmer Practice	8.600	8.600	8.500	8.300	8.100	7.900	7.400
Diamant Large (DL)	Improved bin	8.550	8.550	8.550	8.500	8.325	8.225	8.100
	Farmer Practice	8.500	8.600	8.500	8.300	8.100	8.000	7.800
Lal Pakri Small (LPS)	Improved bin	7.300	7.300	7.300	7.300	7.275	7.100	7.000
	Farmer Practice	7.200	7.200	7.200	7.200	7.000	6.900	6.800
Lal Pakri Large (LPL)	Improved bin	7.300	7.300	7.300	7.325	7.200	7.050	6.950
	Farmer Practice	7.300	7.300	7.300	7.200	7.100	6.900	6.800

Table C6. Vitamin-C content of potato (mg) determined by Titration method in different shelf

Shelf No.	May-13	June-13	July-13	Aug-13	Sep-13	Oct-13	Nov-13
1 (bottom)		7.95	7.95	7.85	7.73	7.60	7.45
2 (middle bottom)		7.95	7.95	7.86	7.80	7.68	7.60
3 (middle top)		7.95	7.95	7.95	7.85	7.80	7.60
4 (top)		7.95	7.95	7.95	7.85	7.80	7.60

Table C7. Total sugar content of potato (gm)

Potato Variety	Type of storage	May-13	June-13	July-13	Aug-13	Sep-13	Oct-13	Nov-13
Diamant Small (DS)	Improved bin		0.860	0.860	0.860	0.865	0.876	0.887
	Farmer Practice		0.860	0.860	0.860	0.865	0.880	0.900
Diamant Large (DL)	Improved bin		0.860	0.860	0.860	0.865	0.873	0.880
	Farmer Practice		0.860	0.860	0.860	0.865	0.880	0.890
Lal Pakri Small (LPS)	Improved bin		0.790	0.790	0.790	0.800	0.810	0.820
	Farmer Practice		0.790	0.790	0.790	0.800	0.810	0.820
Lal Pakri Large (LPL)	Improved bin		0.790	0.790	0.790	0.800	0.810	0.820
	Farmer Practice		0.790	0.790	0.790	0.800	0.810	0.820

Table C8. Total Sugar content of potato (gm) in different shelf

Shelf No.	May-13	June-13	July-13	Aug-13	Sep-13	Oct-13	Nov-13
1 (bottom)		0.825	0.825	0.825	0.832	0.840	0.852
2 (middle bottom)		0.825	0.825	0.825	0.833	0.843	0.853
3 (middle top)		0.825	0.825	0.825	0.833	0.841	0.850
4 (top)		0.825	0.825	0.825	0.833	0.843	0.853

Table C9. Government and market price of potato in different months of 2013, Tk/kg

Month	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Govt. price of Diamant	11.00	11.00	10.00	10.50	10.00	9.00	9.00	10.00
Market price of Diamant	11.00	13.00	13.00	15.00	14.00	13.00	14.00	15.00
Govt. price of Lal Pakri	13.00	13.50	13.00	15.00	18.00	18.00	18.00	19.00
Market price of Lal Pakri	13.00	16.00	16.00	22.00	20.00	20.00	22.00	24.00

Table C10. Cumulative percent of sprouted potato having sprout length greater than 10 mm

Method of storage	Variety of potato	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Improved bin	Diamant in improved bin	0	0	2	9	18	27	32	32
	Lal Pakri in improved bin	0	0	2	8	16	23	28	28
Equivalent Farmer's Traditional Storage	Diamant in Farmer	0	0	3	10	20	30	35	35
	Lal Pakri in farmer	0	0	3	9	18	25	30	30
Difference value	Diamant	0	0	1	1	2	3	3	3
	Lal Pakri	0	0	1	1	2	2	2	2

Table C11. Percentage of shrinkage of different varieties of potato

Variety of potato	Percent of shrinkage (by volume) of potato							
	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Diamant in improved bin	0	0	0	10	10	20	30	30
Lal Pakri in improved bin	0	0	0	10	10	20	30	30
Diamant in Farmer	0	0	0	10	10	20	35	40
Lal Pakri in farmer	0	0	0	10	10	20	35	40

Average Temperature (0 C) of Potato

(* 1-1 means 1st shelf (bottom) 1st cell; DS1 means Diamant Small in 1st shelf so on); DL = Diamant Large; LPS=Lal Pakri Small; LPL=Lal Pakri Large

Table C12. Average Temperature (0 C) of Potato in different points of the improved storage bin

Date	Time	1-1 DS1*	1-2 DL1	1-3 LPL1	1-4 LPS1	2-1 LPL2	2-2 LPS2	2-3 DS2	2-4 DL2	3-1 DS3	3-2 DL3	3-3 LPL3	3-4 LPS3	4-1 LPL4	4-2 LPS4	4-3 DS4	4-4 DL4
28.04.13	AM	28.78	27.26	28.11	27.87	28.88	28.59	28.92	29.41	29.39	29.43	29.48	29.58	30.14	29.73	29.77	26.90
	PM	27.86	26.31	26.61	26.67	27.98	27.90	28.18	28.35	28.50	28.53	28.15	28.02	27.15	29.24	28.88	28.69
29.04.13	AM	27.20	26.56	26.77	26.72	26.65	27.66	27.62	27.67	27.81	27.77	27.61	28.02	28.21	27.88	27.94	27.98
	PM	27.15	27.04	26.99	26.90	27.62	27.60	27.58	27.64	27.55	27.62	27.91	27.80	28.08	28.14	28.03	27.92
30.04.13	AM	27.80	27.41	27.63	27.43	28.20	28.23	28.14	28.04	28.14	28.06	28.19	28.22	28.34	27.86	27.90	28.25
	PM	27.54	27.51	27.49	27.36	28.09	28.60	28.01	28.07	27.72	27.96	28.12	28.07	28.16	28.23	28.15	28.11
		27.29				**28.07**				**28.24**				**28.32**			
01.05.13	AM	28.20	27.94	28.05	27.93	28.66	29.35	28.60	28.62	28.74	28.57	28.67	28.69	28.71	28.48	28.50	28.66
	PM	28.00	27.85	27.89	27.76	28.63	28.90	28.60	28.64	28.67	28.51	28.66	28.60	28.85	28.71	28.77	28.97
02.05.13	AM	28.39	28.05	28.18	27.97	29.01	29.59	28.94	28.96	28.18	28.98	29.11	28.14	29.32	28.90	28.03	29.32
	PM																
08.05.13	AM	24.01	24.00	24.02	24.03	24.11	25.06	23.96	23.97	24.05	23.98	24.00	23.96	29.83	23.94	23.85	23.88
	PM	24.69	24.65	24.69	24.49	24.88	25.67	25.12	24.82	24.64	24.60	24.45	24.79	24.50	24.44	24.40	24.54
09.05.13	AM	24.88	25.05	24.89	24.96	25.14	25.75	24.98	25.03	25.04	24.93	25.02	24.94	24.67	24.88	24.87	24.81
	PM	23.98	24.16	23.97	24.20	24.45	25.28	24.56	24.45	24.43	24.51	24.49	24.45	24.55	24.46	24.44	24.43
12.05.13	AM	24.98	25.31	25.18	25.41	25.58	26.04	25.40	25.52	25.66	25.54	25.81	25.52	25.39	25.67	25.61	25.43
	PM	24.31	24.89	24.24	24.50	25.19	25.39	25.29	25.24	25.10	25.19	25.06	25.11	25.11	25.02	25.02	25.12
13.05.13	AM	25.06	25.37	25.12	25.38	25.64	26.19	25.52	25.62	25.68	25.60	25.72	25.61	25.41	25.59	25.58	25.51
	PM	26.59	26.79	25.53	25.60	26.41	26.04	26.96	26.39	26.50	26.68	26.18	26.71	26.23	25.92	25.92	26.61
14.05.13	AM	25.53	26.12	25.71	26.15	26.49	27.04	26.41	26.51	26.72	26.66	26.91	26.70	26.58	26.73	26.68	26.56
	PM	27.14	27.37	26.15	25.98	26.99	26.65	27.47	26.92	26.07	27.22	26.82	27.26	26.93	26.71	26.61	27.27
15.05.13	AM	26.56	27.02	26.58	27.10	27.51	27.84	27.48	27.45	27.64	27.71	27.74	27.69	28.23	27.71	27.60	27.64
	PM	27.30	28.24	27.16	26.83	28.45	28.02	29.07	28.47	28.51	28.60	28.32	28.69	28.34	28.01	28.11	28.78
16.05.13	AM	27.03	27.77	27.26	27.74	28.33	28.76	28.22	28.38	28.56	28.49	28.82	28.50	28.21	28.57	28.56	28.38
	PM	26.94	26.80	27.01	27.03	27.21	27.62	27.12	27.06	27.26	27.05	27.19	27.51	27.10	27.36	27.30	27.05

17.05.13	AM	25.84	25.73	25.85	26.07	26.10	26.48	25.98	25.99	26.06	26.03	26.23	26.18	26.37	26.19	25.90	26.03
	PM	26.08	25.96	26.01	26.21	26.26	26.47	26.14	26.16	26.20	26.21	26.33	26.27	26.44	26.28	26.06	26.24
18.05.13	AM	26.26	26.35	26.35	26.61	26.88	27.10	26.88	26.70	26.76	26.77	26.93	26.86	27.07	26.82	26.75	26.89
	PM	27.37	27.52	27.17	26.79	28.22	27.81	27.85	27.70	28.71	28.59	28.12	28.30	27.86	27.86	28.18	28.41
19.05.13	AM	27.70	27.74	27.59	27.88	28.27	28.53	28.53	28.26	28.19	28.37	28.25	28.63	28.62	28.46	28.50	28.32
	PM	28.01	28.26	27.76	27.61	28.98	28.48	28.78	28.53	29.44	29.31	29.00	29.00	29.20	28.80	28..73	29.07
20.05.13	AM																
	PM	27.95	28.25	27.79	28.04	28.94	28.72	28.78	28.66	29.35	29.05	28.93	29.00	29.07	29.00	28.94	29.07
21.05.13	AM	27.93	27.94	27.84	28.14	28.52	28.49	28.44	28.59	28.50	28.75	28.74	28.74	28.73	28.73	28.54	28.40
	PM	28.73	28.22	28.17	28.22	30.11	29.76	29.41	29.49	30.02	29.75	29.30	29.44	29.70	29.65	29.49	29.62
22.05.13	AM	28.93	28.81	28.71	29.00	29.56	29.83	29.45	29.48	29.66	29.54	29.83	29.78	29.78	29.88	29.61	29.48
	PM	29.65	28.62	28.50	28.59	29.94	29.79	29.66	29.61	30.00	29.85	29.85	29.81	29.99	29.90	29.84	29.97
23.05.13	AM	28.86	28.75	28.53	29.03	29.54	29.82	29.43	29.45	29.58	29.39	29.91	29.87	29.89	29.98	29.69	29.58
	PM	27.84	27.62	27.22	27.86	28.22	28.52	28.20	28.21	28.37	28.16	28.57	28.45	28.84	28.78	28.49	28.44
24.05.13	AM	27.80	27.68	27.34	27.83	27.97	28.27	27.94	27.91	28.03	27.89	28.21	28.17	28.19	28.26	27.92	27.86
	PM	27.39	27.23	27.07	27.38	27.89	27.93	27.79	27.86	27.86	27.86	27.83	27.79	27.86	27.82	27.85	27.90
25.05.13	AM	28.40	28.43	28.37	28.60	29.21	29.31	29.16	29.13	29.26	29.19	29.38	29.37	29.32	29.30	29.31	29.29
	PM	28.86	28.71	29.04	28.50	30.02	29.56	29.49	29.43	30.09	29.91	29.52	29.64	28.84	29.57	30.01	30.19
26.05.13	AM	28.40	28.43	28.37	28.60	29.21	29.31	29.16	29.13	29.26	29.19	29.38	29.37	29.32	29.30	29.31	29.29
	PM	28.87	28.71	29.04	28.50	30.02	29.56	29.49	29.43	30.09	29.91	29.52	29.64	29.84	29.57	30.01	30.19
27.05.13	AM	29.64	29.66	29.55	29.82	30.72	30.63	30.62	30.38	30.73	30.67	30.75	30.72	31.15	30.93	30.88	30.96
	PM	29.70	29.59	29.67	29.70	30.90	30.67	30.68	30.45	31.20	31.27	30.89	30.89	31.20	31.00	31.28	31.33
28.05.13	AM	29.44	29.28	28.53	29.58	29.94	30.29	30.13	29.95	30.08	29.90	30.33	30.29	30.61	30.65	30.19	30.05
	PM	29.11	28.97	28.35	29.13	29.72	29.81	29.76	29.58	29.83	29.62	29.93	29.89	30.17	30.17	29.91	29.76
29.05.13	AM	28.71	28.76	28.61	28.85	29.37	29.62	29.33	29.30	29.50	29.35	29.65	29.63	29.55	29.62	29.40	29.31
	PM	28.88	28.78	28.65	28.83	29.50	29.53	29.41	29.22	29.53	29.45	29.46	29.45	29.67	29.58	29.50	29.50
30.05.13	AM	28.28	28.26	28.16	28.35	28.55	28.81	28.54	28.55	28.67	28.51	28.84	28.83	28.75	28.79	28.47	28.40
	PM	28.36	28.28	28.18	28.39	28.59	28.77	28.60	28.58	28.70	28.54	28.86	28.86	28.82	28.83	28.52	28.47
Average		**27.37**				**28.03**				**28.07**				**28.09**			

01.06.13	PM	28.14	28.25	28.43	28.38	28.86	28.83	28.85	28.80	28.83	28.81	28.95	28.86	28.90	28.90	28.89	28.88
02.06.13	AM	27.10	27.63	27.70	27.59	28.26	28.28	28.20	28.08	27.99	28.12	27.99	28.47	28.62	28.67	28.56	28.75
	PM	27.77	28.61	27.84	27.84	28.58	28.51	28.60	28.45	28.60	28.88	28.44	28.43	28.48	28.39	28.47	28.70
03.06.13	AM	28.51	28.24	28.71	28.42	29.49	29.49	29.15	29.17	29.30	29.27	29.46	29.42	29.39	29.27	29.12	29.16
	PM	28.76	29.13	29.50	29.11	29.92	30.12	31.26	30.31	30.05	30.42	30.09	30.00	29.96	29.83	30.07	30.38
04.06.13	AM	30.23	29.53	30.31	29.97	31.35	31.29	31.22	31.17	31.42	31.32	31.57	31.58	31.74	31.55	31.50	31.62
	PM	29.99	30.07	30.45	30.41	31.36	31.25	32.43	31.44	31.43	31.40	31.66	31.59	31.78	31.50	31.63	31.80
05.06.13	AM	30.35	29.55	30.52	30.25	31.76	31.37	31.20	31.27	31.47	31.31	31.82	31.75	31.81	31.87	31.45	31.43
06.06.13	AM	29.50	29.02	29.52	29.38	30.22	30.04	29.85	29.88	29.97	29.94	30.13	30.07	30.04	30.09	29.84	29.87
	PM	28.29	28.10	28.43	28.87	29.19	29.04	28.97	29.03	29.06	28.93	29.16	29.29	29.32	29.20	28.97	29.21
08.06.13	AM	27.10	27.49	27.65	27.53	28.01	28.20	28.03	28.01	27.93	27.98	27.91	27.99	27.87	27.91	27.76	27.94
	PM	27.86	27.96	28.04	27.89	28.28	28.51	28.69	28.56	28.27	28.51	28.15	28.32	28.16	28.13	28.16	28.44
09.06.13	AM	28.54	28.32	28.78	28.61	29.33	29.35	29.11	29.14	29.12	29.12	29.21	29.18	29.04	29.04	28.93	28.99
11.06.13	AM	29.77	29.28	29.72	29.55	30.39	30.25	30.14	30.24	30.29	30.20	30.34	30.37	30.35	30.18	30.12	30.25
	PM	29.54	29.06	30.08	30.29	31.17	30.61	31.48	32.23	30.95	31.17	30.96	31.08	30.86	30.63	30.91	31.34
12.06.13	AM	30.39	29.61	30.33	30.07	31.64	31.33	31.28	31.47	31.76	31.63	31.79	31.91	32.12	31.95	31.85	31.99
	PM	30.11	29.50	30.60	30.57	31.66	31.29	32.09	32.65	31.77	31.81	31.89	32.02	31.95	31.68	31.82	32.10
13.06.13	AM	31.26	30.25	31.17	30.82	32.68	32.25	32.25	32.49	32.69	32.58	32.88	32.94	32.94	32.84	32.73	32.85
17.06.13	PM	31.50	31.72	31.02	31.06	33.70	33.45	32.89	33.13	33.88	33.69	33.95	34.19	34.01	34.02	34.38	33.89
18.06.13	AM	31.29	31.60	31.76	31.56	33.26	33.02	33.17	33.14	33.44	33.54	33.74	33.59	33.54	33.51	33.49	33.59
	PM	30.72	31.11	31.20	31.46	32.78	32.67	32.81	32.74	33.12	33.23	33.36	33.33	33.42	33.38	33.52	33.44
19.06.13	AM	31.49	31.91	32.08	31.88	33.52	33.29	33.43	33.44	33.70	33.80	34.01	33.86	33.73	33.72	33.61	33.83
20.06.13	AM	30.03	30.20	30.57	30.58	31.44	31.35	31.54	31.44	31.55	31.75	31.92	31.80	31.47	31.47	31.43	31.52
	PM	31.82	30.15	30.41	30.61	31.52	31.59	31.68	31.46	31.86	31.87	31.79	31.99	32.13	32.07	32.11	32.33
24.06.13	AM	30.63	29.96	30.28	30.27	31.45	31.39	31.66	31.60	31.62	31.93	31.89	31.80	31.67	31.64	31.83	31.69
	PM	31.85	30.18	30.44	30.64	31.55	31.62	31.71	31.47	31.88	31.88	31.81	32.01	32.14	32.09	32.13	32.37
26.06.13	AM	30.44	30.58	30.85	30.74	31.87	31.75	31.86	31.84	32.02	32.10	32.20	32.13	32.00	31.99	31.95	32.07
	PM	29.82	29.86	30.11	30.09	30.77	30.73	30.80	30.73	30.85	30.90	31.05	30.97	30.83	30.77	30.80	30.80
27.06.13	AM	29.12	29.38	29.66	29.72	30.02	30.05	30.09	30.03	30.04	30.19	30.34	30.21	29.81	29.85	29.74	29.89

	PM	28.39	28.54	28.71	28.86	29.07	29.11	29.27	29.22	29.18	29.30	29.29	29.19	29.07	29.04	29.05	29.23
30.06.13	AM	27.62	27.60	27.84	27.91	28.26	28.30	28.31	28.29	28.31	28.37	28.42	28.33	28.24	28.12	28.22	28.32
	PM	27.73	27.84	27.93	27.94	28.56	28.39	28.45	28.51	28.55	28.57	28.63	28.52	28.61	28.52	28.60	28.68
Average		**29.57**				**30.60**				**30.73**				**30.73**			
02.07.13	AM	28.22	28.58	28.74	28.71	29.18	29.17	29.13	29.12	29.20	29.24	29.38	29.22	29.15	29.00	29.09	29.21
03.07.13	AM	28.58	28.78	28.66	28.98	29.21	29.06	29.12	29.01	29.17	29.20	29.13	29.08	29.29	29.16	29.13	29.14
	PM	28.35	29.01	28.65	28.67	28.75	28.93	28.61	29.81	29.81	29.95	29.75	29.89	29.89	29.85	29.75	30.01
04.07.13	AM	28.30	28.87	28.65	29.09	29.56	29.45	29.49	29.43	29.64	29.71	29.62	29.55	29.78	29.59	29.61	29.63
07.07.13	AM	27.62	28.16	28.11	28.39	28.63	28.43	28.53	28.72	28.55	28.58	28.48	28.39	28.57	28.23	28.44	28.46
	PM	28.60	28.40	28.54	28.52	29.30	29.82	29.54	29.32	29.54	29.37	29.48	29.59	29.30	29.38	29.30	29.51
08.07.13	AM	28.63	28.89	28.62	28.98	29.46	29.38	29.42	29.38	29.59	29.57	29.57	29.56	29.64	29.56	29.52	29.57
	PM	29.61	29.29	29.28	29.24	30.67	30.54	30.95	30.54	30.96	30.77	30.83	31.08	30.74	30.80	30.75	30.96
09.07.13	AM	29.18	29.63	29.14	29.64	30.41	30.26	30.42	30.31	30.67	30.73	30.59	30.58	30.86	30.75	30.70	30.72
	PM	29.59	29.57	29.20	29.46	30.66	30.61	30.50	30.56	30.88	30.92	30.66	30.78	30.87	30.84	30.84	30.85
10.07.13	AM	28.83	29.14	28.89	29.33	29.76	29.60	29.75	29.68	29.90	29.96	29.81	29.76	30.01	29.87	29.84	29.87
	PM	29.11	29.16	28.91	29.05	29.19	30.22	30.23	30.02	30.29	30.23	30.15	30.26	30.19	30.18	30.16	30.21
11.07.13	AM	28.76	29.07	28.82	29.23	29.55	29.33	29.52	29.47	29.57	29.68	29.39	29.39	29.67	29.53	29.53	29.52
	PM	28.38	28.49	28.41	28.53	29.12	29.26	29.18	29.11	29.24	29.21	29.13	29.10	29.18	29.10	29.13	29.19
13.07.13	AM	27.58	27.84	27.83	27.99	28.58	28.86	28.70	28.69	28.82	28.79	28.75	28.70	28.76	28.67	28.71	28.75
	PM	28.36	28.35	28.45	28.20	29.49	30.10	29.63	29.52	29.87	29.57	29.79	29.88	29.58	29.60	29.62	29.73
14.07.13	AM	28.47	28.80	28.48	28.83	29.27	29.11	29.29	29.22	29.35	29.43	29.24	29.19	29.42	29.32	29.30	29.28
	PM	28.68	28.57	28.60	28.44	29.72	29.65	29.84	29.69	30.07	29.79	29.94	30.05	29.78	29.89	29.83	29.93
15.07.13	AM	28.70	29.04	28.73	29.02	29.79	29.88	29.81	29.76	30.02	29.98	29.85	29.90	30.05	29.99	29.97	29.98
	PM	29.15	29.09	29.01	28.79	30.59	30.25	30.67	30.54	31.06	30.73	30.91	31.08	30.74	30.94	30.83	30.92
16.07.13	AM	29.30	29.97	29.33	29.84	30.68	30.53	30.76	30.65	31.03	31.11	30.86	30.88	31.25	31.13	31.10	31.08
	PM	29.23	29.86	29.23	29.68	30.63	30.59	30.66	30.61	31.05	31.01	31.01	31.03	31.21	31.12	31.09	31.12
17.07.13	AM	29.34	29.99	29.35	29.60	30.78	30.68	30.86	30.79	30.25	30.27	31.13	31.16	31.49	31.37	31.32	31.33
	PM																
18.07.13	AM	29.02	29.51	29.40	29.62	30.23	30.16	30.00	29.90	30.09	30.08	30.28	30.47	30.45	30.42	30.23	30.52

	PM	28.25	28.68	28.56	28.96	29.56	29.59	29.66	29.75	29.72	29.76	29.70	29.86	29.81	29.85	29.84	29.94
21.07.13	AM	28.17	28.34	28.26	28.47	29.16	29.11	29.14	29.41	29.29	29.29	29.22	29.25	29.26	29.19	29.29	29.31
	PM	29.75	28.88	28.92	29.12	30.47	30.08	30.14	30.80	30.51	30.55	30.38	30.26	30.33	30.42	30.61	30.12
22.07.13	AM	29.23	29.43	29.25	29.55	30.42	30.30	30.23	30.25	30.41	30.35	30.44	30.55	30.52	30.48	30.38	30.60
	PM	29.14	29.30	29.18	29.43	29.49	30.34	30.27	30.35	30.67	30.61	30.56	30.62	30.68	30.60	30.85	30.58
23.07.13	AM	29.54	29.77	29.59	29.79	29.72	30.77	30.62	30.65	30.97	30.88	30.92	31.03	31.15	31.06	31.07	31.16
	PM																
24.07.13	AM	30.37	29.70	29.53	29.94	30.95	30.89	30.80	31.07	31.13	30.97	31.00	31.13	31.13	31.13	31.16	31.23
	PM	30.81	29.76	29.80	30.08	30.67	30.24	30.31	31.45	31.73	31.48	31.65	31.56	31.76	31.67	31.90	31.50
25.07.13	AM	30.17	29.39	29.22	29.57	30.58	30.57	30.50	30.78	30.78	30.67	30.72	30.84	30.84	30.79	30.88	30.93
	PM	30.94	29.84	29.87	30.16	30.65	30.32	30.39	31.45	31.79	31.54	31.70	31.63	31.81	31.74	31.97	31.58
28.07.13	AM	27.70	28.03	27.85	28.10	28.32	28.62	28.35	28.35	28.44	28.41	28.42	28.50	28.46	28.41	28.30	28.62
	PM	27.86	27.88	27.75	27.90	28.47	28.37	28.31	28.44	28.47	28.39	28.35	28.33	28.41	28.35	28.44	28.39
29.07.13	AM	27.94	27.65	27.62	27.73	28.46	28.26	28.28	28.74	28.46	28.36	28.39	28.29	28.43	28.35	28.50	28.31
	PM	28.09	28.04	28.13	28.09	29.54	29.14	29.15	29.91	29.50	29.31	29.42	29.22	29.52	29.43	29.63	29.13
30.07.13	AM	27.99	28.12	27.95	28.19	29.23	29.20	29.11	29.43	29.40	29.29	29.31	29.41	29.43	29.45	29.46	29.49
	PM	28.84	28.78	28.73	28.92	29.67	30.19	30.18	30.85	30.63	30.39	30.50	30.37	30.65	30.64	30.79	30.34
31.07.13	AM	28.49	28.63	28.37	28.71	29.59	29.67	29.53	29.66	29.87	29.73	29.70	29.88	29.85	29.88	29.86	30.02
Average		**28.89**				**29.77**				**29.97**				**30.02**			
01.08.13	AM	27.99	27.84	28.05	28.83	28.84	28.73	28.99	28.98	28.89	28.88	28.97	29.00	28.96	28.98	29.07	29.08
	PM																
04.08.13	AM	29.34	28.94	28.83	29.13	30.00	29.60	29.98	30.12	30.09	29.97	30.05	29.97	30.01	30.03	30.08	30.26
	PM																
05.08.13	AM	29.14	28.89	28.74	29.26	29.88	29.50	29.86	29.80	30.00	30.09	29.92	29.80	30.02	29.91	29.87	30.01
	PM	29.23	29.11	28.54	29.23	30.05	29.73	30.19	30.70	30.32	30.19	30.38	30.27	30.24	30.48	30.55	30.52
06.08.13	AM	28.56	28.10	28.26	28.49	28.97	28.66	28.81	28.69	28.99	29.33	28.84	28.79	28.98	28.75	28.72	28.88
	PM																
07.08.13	AM	27.19	27.34	27.30	27.54	27.68	27.41	27.64	28.02	27.74	28.08	27.63	27.42	27.68	27.25	27.46	27.63
	PM																
08.08.13	AM	27.01	27.60	27.11	27.36	27.84	27.60	27.78	28.48	27.76	27.90	27.77	27.67	27.54	27.55	27.90	27.78
	PM																

09.08.13	AM	27.78	27.76	27.56	27.92	28.38	28.09	28.37	28.55	28.47	28.85	28.39	28.36	28.51	28.30	28.36	28.47
	PM																
10.08.13	AM	27.67	27.71	27.70	28.09	28.46	27.91	28.43	28.43	28.56	28.98	28.45	28.43	28.56	28.09	28.15	28.50
	PM																
11.08.13	AM	27.67	27.71	27.70	28.09	28.46	27.91	28.43	28.43	28.56	28.98	28.45	28.43	28.56	28.09	28.15	28.50
	PM																
12.08.13	AM	27.45	27.49	27.49	27.70	28.05	27.66	28.06	28.17	28.14	28.49	28.04	27.99	28.08	27.78	27.93	28.05
	PM																
13.08.13	AM	26.92	27.35	27.28	27.43	27.77	27.29	27.81	28.33	27.82	28.08	27.83	27.70	27.67	27.49	27.81	27.87
	PM																
14.08.13	AM	27.53	27.44	27.26	27.58	27.98	27.70	28.00	28.09	28.04	28.44	27.92	27.92	28.04	27.88	27.95	28.02
	PM																
15.08.13	AM	27.45	27.32	27.46	27.76	28.29	27.69	30.71	28.22	28.48	28.90	28.07	28.33	28.49	28.12	28.07	28.40
	PM																
18.08.13	AM	28.04	28.40	28.23	28.42	29.15	29.01	29.40	29.41	29.27	29.32	29.23	29.28	29.25	29.33	29.61	29.37
	PM	28.03	29.17	28.38	28.80	30.60	29.69	31.44	31.01	30.52	31.37	31.59	30.71	31.25	31.40	31.72	31.08
19.08.13	AM	28.32	28.84	28.23	28.76	29.78	29.40	29.57	29.42	29.83	29.71	29.55	29.81	29.73	29.60	29.65	29.80
	PM	28.26	29.46	28.40	29.08	30.20	29.72	30.99	30.58	30.61	30.43	31.09	30.54	30.89	30.91	31.40	30.64
20.08.13	AM	28.04	28.56	28.08	28.51	29.34	29.13	29.49	29.22	29.54	29.36	29.27	29.40	29.39	29.30	29.35	29.45
	PM	28.08	29.07	28.15	28.77	29.69	29.33	30.31	29.95	30.09	29.90	30.33	29.93	30.23	30.15	30.42	30.10
21.08.13	AM	27.77	28.27	28.04	28.34	28.99	28.85	28.94	28.46	28.95	28.89	28.54	28.93	28.82	28.62	28.48	28.93
	PM	27.85	28.37	28.31	28.32	28.89	28.79	29.22	29.02	29.03	28.87	28.91	29.14	28.87	28.86	29.13	28.84
22.08.13	AM	27.87	28.38	28.08	28.14	28.56	28.45	28.89	28.89	28.76	28.53	28.53	29.16	28.55	28.59	28.54	28.35
	PM	28.80	28.72	28.45	28.60	29.84	28.93	30.53	30.27	29.99	31.21	29.34	28.78	29.96	31.26	30.46	29.91
24.08.13	AM	29.88	29.92	29.77	29.95	30.78	30.41	30.94	30.54	30.87	30.68	30.91	30.98	30.81	30.62	30.72	30.93
	PM																
25.08.13	AM	30.53	30.65	30.23	30.37	30.95	31.48	31.28	31.01	31.18	31.20	30.87	31.08	30.84	30.88	30.94	31.01
	PM	31.82	31.36	30.96	31.40	32.58	33.02	32.74	32.73	32.74	32.97	31.68	31.66	32.92	32.75	32.62	32.24
26.08.13	AM	30.72	30.64	30.41	30.77	31.72	30.71	31.61	31.25	31.77	31.54	31.71	32.00	31.70	31.59	31.59	31.83
	PM	30.89	30.79	30.71	30.89	31.88	31.67	32.01	31.74	31.97	31.89	31.75	32.00	31.96	32.10	31.93	31.94

27.08.13	AM	29.96	30.11	29.75	30.00	30.74	29.66	30.56	30.29	30.70	30.49	30.31	30.89	30.50	30.45	30.44	30.78
	PM																
29.08.13	AM	27.81	27.92	27.99	27.97	28.57	28.24	28.68	28.64	28.55	28.50	28.51	28.47	28.46	28.41	28.47	28.59
	PM	27.92	27.98	27.91	28.05	28.64	28.48	28.56	28.83	28.60	28.57	28.51	28.51	28.51	28.56	28.52	28.69
Average		**28.58**				**29.41**				**29.50**				**29.49**			
02.09.13	AM	27.719	27.711	28.011	27.8263	28.297	27.4006	28.725	28.848	28.45	28.395	28.4654	28.363	28.301	28.0486	28.286	28.413
	PM																
03.09.13	AM	27.966	27.902	28.089	27.8358	28.404	27.7758	29.123	28.721	28.73	28.749	28.7859	28.687	28.686	28.3883	28.631	28.756
	PM	28.141	27.947	28.078	28.1416	28.893	28.5176	28.978	29.036	28.97	29.026	28.936	28.908	28.841	28.8804	28.919	29.027
04.09.13	AM	27.991	27.952	28.146	27.9745	29.145	28.4614	29.011	29.637	29.07	28.985	28.9567	28.96	28.846	28.8418	28.931	29.156
	PM	28.278	28.369	28.372	28.354	29.76	29.3297	29.365	30.17	30.5	29.477	29.5083	29.521	29.356	29.4775	29.564	29.814
05.09.13	AM	27.684	27.731	27.85	27.6803	28.279	27.5858	28.847	28.823	28.56	28.472	28.6302	28.518	28.482	28.247	28.484	28.567
	PM	28.399	28.384	28.369	28.5747	29.227	29.1297	29.182	29.131	29.63	29.817	29.3079	29.311	29.422	29.5977	29.743	29.912
08.09.13	AM	29.008	28.768	28.51	28.3112	29.805	29.4579	29.58	29.929	29.72	29.684	29.6511	29.565	30.17	29.8391	29.937	29.896
	PM	28.693	28.491	28.49	28.0494	29.204	29.0668	29.629	30.081	29.54	29.828	29.7142	29.699	30.752	29.8808	29.676	30.092
09.09.13	AM	29.071	28.845	28.562	28.4146	29.852	29.5466	29.576	29.938	29.76	29.721	29.683	29.604	30.185	29.8709	29.965	29.939
	PM	29.105	28.884	28.857	28.6561	29.875	29.6666	30.094	30.517	30.18	30.372	30.3168	30.3	31.174	30.5631	30.326	30.689
10.09.13	AM	28.599	28.903	28.548	27.8424	29.255	28.6866	29.604	29.615	29.31	29.328	29.2235	29.115	29.276	29.1001	29.303	29.362
	PM	29.106	29.012	28.845	28.6601	29.757	29.4839	29.976	30.141	29.82	29.958	29.9634	29.899	30.33	30.0047	29.853	30.104
11.09.13	AM	29.035	28.874	28.397	28.4748	29.28	28.7981	29.446	29.453	29.31	29.329	29.3047	29.177	29.226	29.1011	29.352	29.348
	PM	28.871	28.781	28.667	28.7391	29.579	29.3982	29.811	29.826	29.82	30.033	29.9692	29.937	30.851	30.0982	29.879	30.244
12.09.13	AM	30.521	29.286	29.055	28.9826	30.946	29.9359	30.985	31.157	30.6	30.738	30.9546	30.438	30.662	30.5026	30.749	30.955
	PM	31.665	29.852	29.495	29.3948	31.907	30.7513	31.596	31.616	31.37	31.663	31.6842	31.316	32.028	31.5564	31.359	31.927
14.09.13	AM	30.687	29.803	29.551	30.0688	30.947	31.0447	31.171	31.287	31.45	31.49	31.2821	31.383	31.179	31.328	31.634	31.596
	PM	29.918	30.149	31.273	31.0198	32.101	31.9211	32.444	32.363	33.07	32.143	32.3077	32.728	32.232	31.9504	32.539	32.757
15.09.13	AM	29.932	29.155	28.946	29.0104	30.294	29.3365	30.194	30.001	30.17	30.146	30.098	29.923	30.136	30.1878	30.088	30.167
	PM	29.372	29.67	30.589	30.4339	31.49	31.6225	31.859	31.724	32.31	31.482	31.8378	31.917	31.555	31.242	31.744	31.939
16.09.13	AM	29.899	30.144	29.666	30.933	31.136	30.8808	31.313	31.306	31.22	30.946	30.8922	31.12	31.069	30.8672	31.115	31.317
	PM	29.66	29.883	30.754	30.5795	31.616	31.7264	31.964	31.773	32.36	31.552	31.8971	31.959	31.603	31.2973	31.805	32.018

17.09.13	AM	30.047	30.371	29.933	31.1933	31.319	31.136	31.532	31.431	31.3	31.032	30.9617	31.25	31.147	30.9512	31.219	31.504
	PM	30.152	30.33	31.411	31.1748	32.173	32.007	32.507	32.403	33.16	32.193	32.3819	32.753	32.266	31.9871	32.577	32.805
18.09.13	AM	29.112	29.643	30.03	30.1187	30.435	30.459	30.608	30.722	30.71	30.971	30.8112	30.846	30.887	31.0428	30.903	30.814
	PM	29.833	30.072	30.622	30.602	30.723	30.5947	30.875	30.858	31.04	30.67	30.7072	30.88	30.727	30.721	30.805	30.856
19.09.13	AM	29.577	29.897	30.462	30.4166	30.578	30.4051	30.762	30.862	30.94	30.595	30.6203	30.81	30.67	30.6679	30.728	30.76
	PM	30.288	30.623	31.311	30.9522	31.38	31.0552	31.749	31.682	31.57	31.53	31.1845	31.5	31.648	31.641	31.683	31.753
22.09.13	AM	30.495	30.819	31.437	31.0417	31.561	31.3952	31.849	31.706	31.7	31.621	31.1676	31.617	31.695	31.6785	31.753	31.872
	PM																
23.09.13	AM	30.495	30.819	31.437	31.0417	31.561	31.3952	31.849	31.706	31.7	31.621	31.1676	31.617	31.695	31.6785	31.753	31.872
	PM	31.207	31.476	30.582	30.3498	31.385	31.2874	31.586	31.586	31.42	31.517	31.6873	31.507	31.632	31.503	31.551	31.623
24.09.13	AM	31.401	31.6	30.701	30.4876	31.498	31.484	31.653	31.601	31.47	31.575	31.7373	31.558	31.688	31.5653	31.604	31.684
	PM																
25.09.13	AM	29.961	29.871	29.512	29.1035	29.941	30.1649	30.176	30.124	29.96	30.181	30.5134	30.103	30.501	30.2497	30.073	30.139
	PM	28.882	29.027	28.93	28.5663	29.067	28.8319	29.456	29.335	29.11	29.431	29.8284	29.535	29.856	29.6898	29.294	29.231
26.09.13	AM	28.823	29.167	28.614	28.3407	29.022	28.6121	28.99	29.137	29.11	29.105	28.9253	28.859	28.892	28.9333	28.719	29.08
	PM	29.992	30.42	29.526	28.8431	30.175	30.0431	30.042	30.072	30.27	30.05	29.9535	29.879	29.708	29.7727	30.693	30.627
29.09.13	AM	28.181	28.219	28.353	27.6826	28.327	27.9696	28.642	28.769	28.41	28.493	28.8753	28.535	28.795	28.5044	28.352	28.367
	PM																
30.09.13	AM	26.609	27.12	26.93	26.5014	27.043	26.912	27.049	27.144	27.19	26.998	26.9324	26.848	26.927	26.8833	26.867	26.873
	PM	26.893	27.336	27.098	26.8614	27.22	27.1932	27.15	27.173	27.3	27.095	27.0369	26.954	27.026	27.0071	26.986	27.015
Average		**29.26**				**30.08**				**30.17**				**30.21**			
01.10.13	AM	25.97	26.63	26.66	26.22	26.58	26.00	26.77	27.05	26.76	26.82	26.54	26.57	26.69	26.40	26.63	26.63
	PM	26.864	27.511	27.366	26.2629	27.483	27.178	27.505	27.788	27.7	27.34	27.4469	27.211	27.305	27.3954	27.433	27.488
02.10.13	AM	27.571	28.057	28.191	26.486	28.125	27.4951	28.644	29.334	28.64	28.053	28.7777	28.432	28.115	28.1003	27.999	28.568
	PM	28.466	29.97	29.639	28.119	29.704	29.8542	29.784	29.849	29.83	29.55	30.3397	29.552	29.9	30.3431	30.51	30.748
03.10.13	AM	27.813	28.977	29.067	27.9165	28.997	28.9001	29.134	29.195	29.13	29.108	29.1339	29.071	29.027	29.1012	29.158	29.275
	PM	28.096	29.056	29.161	28.4331	29.1	29.024	29.195	29.221	29.15	29.122	29.1534	29.113	29.034	29.1462	29.178	29.306
04.10.13	AM	27.671	28.662	28.701	27.8183	28.676	28.5495	28.804	28.819	28.75	28.774	28.7114	28.652	28.654	28.6738	28.741	28.794
	PM																
06.10.13	AM	25.795	26.694	27.286	26.5051	26.933	26.3636	32.545	27.176	26.97	27.388	26.8715	27.388	27.124	26.9678	27.191	27.129

	PM	26.011	26.489	26.788	26.5303	26.549	25.9463	31.453	27.162	26.69	26.985	26.6997	27.014	26.705	26.4976	26.673	26.7
07.10.13	AM	26.034	26.433	26.866	25.2194	26.639	25.9387	34.486	27.59	27.13	26.521	27.0986	26.945	26.56	26.4865	26.437	26.978
	PM																
08.10.13	AM	27.617	27.505	27.584	28.2649	27.974	28.5139	31.711	28.584	28.55	28.561	28.6176	29.032	28.272	28.35	28.368	28.612
	PM	28.222	28.209	28.029	29.5976	28.84	29.81	30.647	29.944	29.7	29.777	29.9395	30.38	29.527	29.8422	29.725	30.132
09.10.13	AM	27.298	27.518	27.661	29.4571	28.967	28.8466	30.403	29.091	28.65	28.964	28.8402	29.663	28.578	28.4923	28.74	28.736
	PM	27.748	27.79	29.328	28.6052	28.936	29.3936	28.821	28.742	29.13	28.977	29.6303	28.859	28.594	28.7143	28.736	
10.10.13	AM	26.311	26.228	26.561	27.8315	26.84	27.9219	28.457	27.246	27.4	27.71	27.3815	27.384	27.516	27.2882	27.464	27.467
	PM	29.397	29.622	30.363	31.9204	31.274	31.9125	32.117	31.992	31.71	31.722	31.248	31.889	31.693	31.5629	31.205	31.362
13.10.13	AM	28.802	28.41	28.479	28.4226	29.114	28.8582	30.27	29.198	29.32	29.105	29.2401	29.125	29.187	29.2012	29.178	29.264
	PM																
20.10.13	AM	30.19	30.378	29.843	29.2946	30.383	30.0035	31.993	30.461	30.31	30.266	30.5587	30.517	30.193	30.9661	30.746	30.574
	PM																
21.10.13	AM	27.869	27.585	28.016	27.8479	27.784	27.8184	27.433	27.065	27.94	27.849	27.7028	27.623	27.72	27.1391	27.074	27.199
	PM																
22.10.13	AM	27.373	27.106	27.7	27.2097	27.522	27.4782	27.785	26.917	27.81	27.693	27.5679	27.489	27.608	27.0256	26.99	27.024
	PM	27.611	27.71	27.417	27.1536	27.695	27.4863	28.338	27.697	27.63	27.563	27.6018	27.51	27.456	27.5848	27.486	27.448
23.10.13	AM	25.697	25.617	24.926	24.7647	25.482	24.9588	25.337	25.496	25.49	25.24	24.967	25.282	25.014	24.8138	24.767	24.898
	PM																
27.10.13	AM	25.347	25.284	24.771	24.2492	25.207	24.4714	26.245	25.467	25.3	25.116	24.818	25.041	24.852	24.6092	24.617	24.75
	PM																
28.10.13	AM	26.61	26.63	26.02	25.5	26.6	26.11	27.47	26.74	26.73	26.46	26.47	26.66	26.27	26.08	26.26	26.32
	PM	26.99	26.94	26.59	26.35	26.81	26.5	27.19	26.84	26.84	26.375	26.64	26.7	26.75	26.55	26.5	26.57
29.10.13	AM	26.55	26.56	26.16	25.04	26.57	25.9	27.76	26.88	26.75	26.58	26.45	26.58	26.36	26.23	26.31	26.35
	PM	27.2	27.17	26.67	26.57	26.99	26.7	27.03	27.02	26.97	26.88	26.75	26.85	26.69	26.64	26.61	26.72
30.10.13	AM	27.05	27.02	26.61	26.41	26.86	26.53	27.12	26.91	26.87	26.78	26.66	26.74	26.6	26.56	26.52	26.61
	PM	28.13	28.31	27.87	27.75	28.2	28.23	28.75	28.69	28.25	28.23	28.52	28.43	28.17	28.09	28.54	28.49
31.10.13	AM	25.91	26.02	25.79	25.24	26.03	25.66	26.6	26.01	26.16	26.07	25.92	25.99	25.9	25.87	25.8	25.79
	PM																

Average		27.39				28.09				27.90				27.73			
03.11.2013	AM	25.409	25.831	25.533	25.2773	25.807	25.4714	26.318	25.701	25.8	25.622	25.624	25.44	25.679	25.5182	25.338	25.458
	PM	25.97	26.469	26.015	25.9628	26.303	26.1585	26.373	26.097	26.14	26.201	26.0388	25.916	26.062	25.9286	25.791	25.937
04.11.2013	AM	25.66	26.17	25.796	25.6211	25.288	25.8648	26.412	25.963	26.02	26.073	25.9008	25.754	25.943	25.7988	25.644	25.726
	PM																
05.11.2013	AM	25.143	25.484	25.211	25.2657	25.48	25.2137	25.968	25.406	25.57	25.605	25.32	24.986	25.416	25.193	24.975	25.168
	PM	25.541	27.28	28.049	26.9959	27.24	27.5338	27.695	26.988	27.6	27.285	27.4908	27.659	28.105	28.0435	28.023	27.854
06.11.2013	AM	24.803	25.301	24.885	24.8774	24.218	24.9275	25.502	25.05	25.15	25.234	24.9636	24.8	25.101	24.8744	24.656	24.813
	PM	25.735	27.455	28.174	27.1238	27.131	27.6506	27.777	27.084	27.68	28.122	28.0461	27.718	28.129	28.0956	28.081	27.926
07.11.2013	AM	25.344	25.189	25.316	25.065	26.348	26.2683	26.981	26.307	26.19	26.245	26.4051	26.147	26.017	26.3063	26.444	26.254
	PM																
10.11.2013	AM	25.338	25.205	25.37	25.1106	26.38	26.3374	27.03	26.348	26.22	26.278	26.4334	26.196	26.048	26.339	26.508	26.33
	PM	26.211	25.911	26.05	25.5171	28.282	28.2286	28.145	28.679	28.23	28.444	28.5616	28.55	28.128	28.8731	29.098	28.7
11.11.2013	AM	24.51	24.376	24.297	24.3394	25.437	25.2902	25.851	25.344	25.32	25.329	25.4038	25.204	25.176	25.3488	25.36	25.268
	PM	24.326	24.318	24.246	25.4695	25.387	25.9995	25.442	25.281	25.33	25.404	25.233	25.081	25.355	25.5014	25.356	
12.11.2013	AM	24.789	24.457	24.507	24.4965	25.569	25.4762	26.04	25.488	25.41	25.416	25.4921	25.338	25.264	25.4395	25.571	25.477
	PM	26.47	26.767	26.076	25.7499	28.472	28.3483	28.84	28.764	28.44	28.573	28.5794	28.588	28.257	28.8988	29.069	28.667
13.11.2013	AM	24.301	24.218	24.097	24.0796	25.328	25.1906	25.821	25.298	25.19	25.227	25.3195	25.108	24.999	25.2656	25.319	25.169
	PM	26.414	26.532	26.4	26.8282	26.168	26.5934	26.793	26.742	26.24	26.359	26.6365	26.486	26.029	26.083	26.372	26.365
17.11.2013	AM	24.785	24.848	24.61	25.1225	24.398	24.6166	24.517	24.692	24.48	24.337	24.1632	24.341	24.1	24.0333	23.899	24.081
	PM	26.574	26.667	26.413	26.8551	26.303	26.6993	26.872	26.778	26.33	26.424	26.7072	26.515	26.098	26.1421	26.454	26.478
18.11.2013	AM	25.14	25.169	24.887	25.4062	24.605	24.8833	24.736	24.873	24.65	24.512	24.3197	24.509	24.228	24.1634	24.027	24.228
	PM	26.773	26.263	26.241	25.9282	26.542	26.773	26.637	26.766	26.53	26.588	26.9223	27.429	25.974	26.4805	27.147	26.901
19.11.2013	AM	24.757	24.821	24.493	24.9977	24.549	24.7974	24.653	24.753	24.59	24.543	24.4126	24.427	24.281	24.1814	24.138	24.377
	PM	26.787	26.284	26.185	25.878	26.515	26.7494	26.604	26.728	26.5	26.511	26.9209	27.444	25.931	26.4535	27.108	26.851
20.11.2013	AM	24.306	24.356	24.086	24.4703	24.196	24.3242	24.112	24.338	24.23	24.14	23.9971	24.003	23.929	23.8296	23.719	23.947
	PM	26.837	26.636	26.055	25.8355	26.186	26.2443	26.274	26.242	26.51	26.388	27.001	27.309	25.932	26.4274	27.06	26.814
21.11.2013	AM	24.684	24.331	23.432	23.278	23.709	23.8181	23.96	24.36	24.06	23.841	24.5664	24.856	23.38	23.745	23.937	23.605
	PM																
24.11.2013	AM	24.933	24.617	23.636	23.4285	23.886	23.4831	24.126	24.573	24.22	24.03	24.7621	25.038	23.479	23.881	24.118	23.771
	PM	26.487	26.089	26.038	25.7161	25.366	25.6073	25.481	25.66	26.4	26.477	26.4767	27.47	25.835	26.3931	27.069	26.753

25.11.2013	AM	23.343	23.154	22.772	22.8144	23.045	23.1202	23.126	23.375	23.14	23.219	23.3532	23.723	22.989	23.0325	23.113	22.901
	PM																
28.11.2013	AM	27.057	26.641	27.099	26.5143	27.085	27.2034	27.342	27.103	27.09	27.004	27.2653	27.625	26.643	26.9395	27.492	27.572
	PM																
Average		**25.42**				**25.86**				**25.90**				**25.77**			

Table C13. Measured air temperature at different points

Date	**Item**	**Time**	**Air Temperature at different shelf**					**Water Temp.**	**Room temp.**	**Outside Temp.**
			Above water	**1st Shelf (bottom)**	**2nd Shelf (bottom middle)**	**3rd Shelf (top middle)**	**4th Shelf (top)**			
28.04.13	Temperature	AM	30.8	**27.4**	**28**	**27.4**	**27.4**	**27.5**	**25.5**	27.5
		PM	26.8	27	28.3	29.2	29.3	26.8	26.3	28
29-04-13	Temperature	AM	26.8	**27.1**	**27.9**	**28.3**	**28.4**	**27.1**	**25.8**	27
		PM	27.6	27.2	28	28.3	29.1	27.2	28	31.05
30.04.13	Temperature	AM	27.4	**28.1**	**28.2**	**28.3**	**28**	**27.7**	**26**	28
		PM	28.7	28.6	28.9	29	29.4	28.1	27.5	30
Average			**28.02**	**27.57**	**28.22**	**28.42**	**28.60**	**27.40**	**26.52**	**28.59**
01.05.13	Temperature	AM	28	28.9	29	29.1	29.1	28.1	26.5	31
		PM	29	28.8	29.1	29.2	29.7	28.1	28	31
02.05.13	Temperature	AM	28	**29.2**	**29.4**	**29.6**	**29.5**	**28.2**	**27**	33
		PM								
08.05.13	Temperature	AM	24.4	24.4	24.5	24.4	24.7	25.3	23	20
		PM	25.8	25.5	25.4	25.5	25.4	25.4	24	21.5
09.05.13	Temperature	AM	24.8	24.7	25.2	25.2	25.2	25.5	23	23
		PM	25	24.4	25	25.1	25.4	25.1	23.5	25
12.05.13	Temperature	AM	24.8	25	25.4	25.9	25.7	25.7	23	27
		PM	26	25.6	25.7	25.8	25.9	25.2	24.9	27
13.05.13	Temperature	AM	25.3	25.5	25.7	25.9	25.9	25.7	24	27.4
		PM	27.3	27.1	27	27.1	27.1	25.5	26.5	28

14.05.13	Temperature	AM	25.7	26.4	26.7	26.7	27	26	25	27
		PM	27.7	27.2	27.5	27.5	27.7	25.8	27	28.5
15.05.13	Temperature	AM	26.08	28.4	28	28.7	29.4	26.5	27	30
		PM	26.8	28.7	28.9	28.9	29.2	26.5	28	29.5
16.05.13	Temperature	AM	26.8	27.7	28.3	28.4	28.4	27	24	24.5
		PM	26.4	26.9	27.1	27.4	27.3	26.9	24.5	25
17.05.13	Temperature	AM	26.1	26.9	26.8	26.8	27.5	26.5	25.5	28.5
		PM								
18.05.13	Temperature	AM	26.7	27.4	27.5	27.9	28.9	26.7	26	30
		PM	28.5	28.8	29.6	29.1	29	26.8	27	30
19.05.13	Temperature	AM	27.4	**28.3**	**28.5**	**28.6**	**28.8**	**27.3**	**26**	31
		PM	29.4	29.5	30.3	29.9	29.9	27.3	28	29
20.05.13	Temperature	AM	28	**28.7**	**28.7**	**29.2**	**29.6**	**27.9**	**26**	30.5
		PM	29	29.1	29.8	29.7	29.8	27.8	27.5	28.5
21.05.13	Temperature	AM	27.7	**28.6**	**29**	**29.1**	**29.5**	**27.8**	**27**	34
		PM	29.5	30.6	30.6	30.7	30.6	27.7	28	29
22.05.13	Temperature	AM	28.4	**29.4**	**29.6**	**29.9**	**29.9**	**28.3**	**27**	32
		PM	29.5	29.5	30.08	30.07	31.04	27.8	28.5	29
23.05.13	Temperature	AM	28.1	**28.5**	**29.1**	**29.4**	**29.23**	**28.3**	**26.6**	27
		PM	27.8	27	28.5	28.7	29.1	27.7	27	27.5
24.05.13	Temperature	AM	27.3	**27.6**	**27.9**	**28.1**	**28.4**	**27.9**	**26**	27
		PM	27.5	28.3	28.4	28.4	28.6	27.5	27	29
			28.20	29.30	29.60	29.70	30.30	28.30	27.60	30.60
26.05.13	Temperature	AM	28.2	**29.3**	**29.6**	**29.7**	**30.3**	**28.3**	**27.6**	30.6
		PM	30.9	30.6	30.91	31	31.1	28.2	30	31
27.05.13	Temperature	AM	29.4	31.1	31.5	31.8	32.7	29	29	33
		PM	30.8	31.3	32.1	32.2	32.2	29	31	32
28.05.13	Temperature	AM	29.1	29.6	30.3	30.6	30.9	28.9	27	28.5
		PM	28.9	29.6	30.1	30.2	30.6	28.4	28.5	29.5

29.05.13	Temperature	AM	28.5	29.4	29.7	29.9	29.9	28.8	27	26
		PM	28.9	29.8	30.2	30.2	30.8	28.8	28	27
30.05.13	Temperature	AM	28.1	28.7	29.1	29.5	29.5	28.7	27.85	27
		PM	28.1	28.8	29.2	29.1	29.6	28.8	28	28.5
Average			**27.63**	**28.14**	**28.48**	**28.60**	**28.85**	**27.33**	**26.59**	**28.47**
02.06.13	Temperature	AM	27.4	28.3	28.4	28.7	29.4	27.9	28.5	34.5
		PM	28.5	29.5	29.4	29.2	29.7	28	30	35
03.06.13	Temperature	AM	28.4	29.6	29.8	30.1	30.7	28.7	30	35
		PM	28.1	28.8	29.1	29.2	29.6	28.8	28	28.5
04.06.13	Temperature	AM	29.7	31.5	32	32.3	32.9	29.7	31	33
		PM	31.7	31.9	32.1	32.6	32.9	29.7	32	33
05.06.13	Temperature	AM	29.7	30.5	30.7	31.2	31.1	30	27	28
		PM								
06.06.13	Temperature	AM	29.2	29.9	30.3	30.2	30.5	29.8	28	31
		PM	29	29.1	29.4	29.6	29.7	28.9	27	27
08.06.13	Temperature	AM	28.3	28.6	28.7	28.6	28.8	28.6	27	30
		PM	28.7	29.3	29.2	29.2	29.3	28.6	28.5	31
09.06.13	Temperature	AM	28.6	29	29.3	29.2	29.4	29.1	30	30.2
		PM	28.7	29.2	29.4	29.3	29.7	29.5	27	31
10.06.13	Temperature	AM	28.7	29.4	29.5	29.6	29.8	29.4	27	31
		PM	30.2	30.6	30.4	30.2	30.4	29.3	28.5	30.5
11.06.13	Temperature	AM	29.4	30.8	31.1	31.2	32.1	29.8	31	37
		PM	31.6	31.7	32.6	32.2	32.2	29	31	34
12.06.13	Temperature	AM	29.7	31.8	32.4	32.7	33.4	29.9	32	33
		PM	31.9	32.2	33	32.7	32.9	29.3	32	33
13.06.13	Temperature	AM	30.3	31.9	32.6	32.8	33	30.2	30	32.5
		PM	30.9	31.8	32.7	32.6	33	29.7	31	31
16.06.13	Temperature	AM	29.6	30	31.3	31.4	31.8	30.3	29	31
		PM								

18.06.13	Temperature	AM	31.3	33	33.7	33.9	33.9	31.4	32	38
		PM	31.9	32.4	33.6	33.7	34.2	31.1	33.5	33.5
19.06.13	Temperature	AM	31.6	33	33.7	33.9	33.8	31.6	30.5	32
		PM								
20.06.13	Temperature	AM	30.4	31.4	31.6	31.8	31.7	30.9	30	31
		PM	30.5	31.8	31.7	32	31.9	30.8	31.5	32
23.06.13	Temperature	AM	30.6	31.8	32.2	32.2	32.4	30.6	30	31
		PM	30.6	31.8	32.4	32.5	32.8	30.3	31	31.5
24.06.13	Temperature	AM	30.8	31.7	32.2	32.3	32.2	30.3	29	31
		PM								
26.06.13	Temperature	AM	29.9	30.3	30.6	30.4	31	30.8	29.5	30
		PM	30.1	31	31.3	31.4	31.6	30.6	28.5	28
27.03.13	Temperature	AM	29.1	29.5	29.6	29.8	29.7	30.5	26	27
		PM	29	29	29.4	29.6	29.7	29.8	27	28
30.06.13	Temperature	AM	28	28.5	28.5	28.7	28.9	29.9	26	27
		PM	28	29.2	29.4	29.4	29.5	30	27	27
Average			**29.73**	**30.55**	**30.93**	**31.01**	**31.27**	**29.80**	**29.36**	**31.31**
01.07.13	Temperature	AM	29	29.2	29.1	30.1	30.8	30.2	27	27.5
		PM	27.8	29.1	29.2	29.4	29.3	29.6	27	29
03.07.13	Temperature	AM	28.9	29.3	29.4	29.5	31	29.6	28	31
		PM	28.9	29.4	29.6	29.7	31.2	30	29	32
04.07.13	Temperature	AM	29.1	29.4	29.9	30.1	30.9	32.2	29	34
		PM								
07.07.13	Temperature	AM	28.2	28.5	28.9	29	29.3	29.4	27	30
		PM	29.9	30.2	30.2	30.3	30.6	30.7	29	30
08.07.13	Temperature	AM	29.7	29.9	30.2	30.2	30.8	30.7	29	30.5
		PM	29.7	29.8	30.1	30.2	30.6	30.8	28.5	29
09.07.13	Temperature	AM	29.1	29.6	29.7	29.6	30.1	30.3	29	31
		PM	29.8	30.8	31.2	31.3	31.7	28.2	27.5	28

10.07.13	Temperature	AM	29.2	30.1	30.4	30.5	30.8	29	28	30
		PM	29	30.5	30.7	30.6	31.4	28.9	28	29
11.07.13	Temperature	AM	29	29.3	29.4	29.8	29.8	28.7	27	28
		PM	29	29.4	29.6	29.7	30.2	28.7	27	29
13.07.13	Temperature	AM	28.7	29.2	29.3	29.4	29.7	28.3	27.5	32.5
		PM	29.6	30.4	30.6	30.6	30.7	29	28	29
14.07.13	Temperature	AM	28.9	29.4	29.6	29.5	29.7	29.1	27	28
		PM	29.7	30.2	30.3	30.6	30.5	28.9	29	30.5
15.07.13	Temperature	AM	29.7	30.2	30.3	30.6	30.5	28.9	29	30.5
		PM	30.4	31.4	31.6	31.8	32	29.7	30.5	30
16.07.13	Temperature	AM	30.2	30.4	30.4	30.5	30.5	27.6	29	31
		PM	29.7	31.3	31.6	31.7	32	29.6	29	31
17.07.13	Temperature	AM	28.9	31.3	31.7	31.8	32.2	29.4	29	32.5
		PM								
18.07.13	Temperature	AM	29.5	30.3	30.5	30.6	30.8	29.4	27	28
		PM	29.5	30.1	30.4	30.5	30.7	29.4	27.5	29.5
21.07.13	Temperature	AM	29.3	29.5	29.7	29.7	29.7	28.9	27.5	30
		PM	28.8	28.9	29	29.1	29	28.1	30.5	31.5
22.07.13	Temperature	AM	29.4	30.4	30.7	30.8	30.9	29.1	28.5	32.5
		PM	29.9	32.2	32.3	32.6	32.6	29.4	30	33.5
23.07.13	Temperature	AM	30	31.5	31.6	31.8	31.4	29.6	30	32
		PM	31.2	31.2	31.2	31.6	31.9	30.6	29	29.5
25.07.13	Temperature	AM	30.6	30.9	31.1	31.4	31.6	30.3	30	31
		PM	31.7	31.9	32.1	32.4	32.5	31.3	31	32
28.07.13	Temperature	AM	28.2	28.5	28.7	28.8	28.9	27.1	26	26.5
		PM	29	29.2	29.2	29.4	29.5	27.9	27	27.5
29.07.13	Temperature	AM	28.7	28.9	28.9	29	29.2	28.4	29	32
		PM	28.9	28.6	29.6	29.7	29.8	28.3	31.5	33
30.7.13	Temperature	AM	29.6	29.6	29.8	30.1	30.3	28.4	29	30

		PM	30.8	31.1	31.2	31.5	31.5	29.6	30.5	31
31.07.13	Temperature	AM	29.6	29.7	29.9	30.2	30.6	29.4	28	29
		PM								
Average			**29.43**	**30.02**	**30.22**	**30.38**	**30.66**	**29.33**	**28.54**	**30.28**
01.08.13	Temperature	AM	29.4	29.5	29.5	29.7	29.8	28.7	28	29
		PM	30.2	30.6	31.4	31.6	31.8	28.7	30	31.5
04.08.13	Temperature	AM	30.2	30.4	30.8	31	31.2	28.6	30.5	31.5
		PM	30.2	30.6	30.7	31.2	31.4	28.6	31	33
05.08.13	Temperature	AM	29.8	30.2	30.5	30.7	30.8	28.5	29	30
		PM	31	30.5	30.8	31.1	31.6	30	30	31
06.08.13	Temperature	AM	28.9	29	29.3	29.4	29.2	27.9	25	25
		PM								
07.08.13	Temperature	AM	28.1	28.1	28.1	28.2	28.3	28	25	28
		PM								
08.08.13	Temperature	AM	28.6	28.1	28.3	28.4	28.5	28.2	27.5	33
		PM								
10.08.13	Temperature	AM	28.8	28.6	28.7	29	29.2	28.4	26	34
		PM								
11.08.13	Temperature	AM	28.4	28.6	28.7	29	28.9	28.2	25.5	27
		PM								
12.08.13	Temperature	AM	28.2	28.4	28.6	28.7	28.7	27.9	25.5	26.5
		PM								
13.08.13	Temperature	AM	28.2	28.3	28.3	28.4	28.7	27.8	26.5	29
		PM								
14.08.13	Temperature	AM	28.3	28.2	28.4	28.5	27.7	28	25.5	30
		PM								
15.08.13	Temperature	AM	28.2	28.2	28.6	28.7	28.9	28.1	25.5	26.5
		PM								
18.08.13	Temperature	AM	29.6	29.4	29.8	29.6	30.2	29	30	36

		PM	30.9	31.6	31.8	31.9	32.2	29.2	31	33
19.08.13	Temperature	AM	29.5	29.6	29.8	29.9	30.5	29.2	30	33
		PM	30.8	31.3	31.4	31.5	31.8	29.3	30	31
20.08.13	Temperature	AM	29.5	29.6	29.8	29.8	30.3	29	29	33
		PM	30.2	30.8	30.9	31.2	31.5	29.2	30	32
21.08.13	Temperature	AM	28.4	28.6	28.7	28.9	29.1	28.3	26	27
		PM	29.2	29.5	29.5	29.7	29.9	28.4	27	28
22.08.13	Temperature	AM	28.9	29.1	29.9	29.6	30.5	28	28.5	33
		PM	31.6	31.8	31.9	32.5	32.7	28.4	29.5	30
24.08.13	Temperature	AM	31.1	31	31.2	31.4	31.5	28.2	29	32
		PM								
25.08.13	Temperature	AM	32	32.1	32.3	32.4	32.5	28.4	30	35
		PM	31.8	31.3	31.9	31.8	31.9	28.2	28	32
26.08.13	Temperature	AM								
		PM	30.6	33.6	33.8	34	34.5	30.4	31.5	32
27.08.13	Temperature	AM	33	33.1	33.2	33.5	33.6	28.4	31	32
		PM	30.1	30.2	30.3	30.6	30.7	28.4	22	28
29.08.13	Temperature	AM	29.1	29.1	29.4	29.6	29.7	28.2	28	31
		PM	29.4	29.7	29.9	30	30.3	28.4	29	30
Average			**29.76**	**29.96**	**30.19**	**30.35**	**30.55**	**28.55**	**28.18**	**30.70**
01.09.13	Temperature	AM	28.9	29.3	29.5	29.5	29.6	28.3	26.5	31
		PM								
02.09.13	Temperature	AM	28.3	28.7	28.8	29	29.1	28.2	27	31.5
		PM								
03.09.13	Temperature	AM	28.3	28.7	29	29.1	29.3	28	26.5	28.5
		PM	29.9	29.9	30.2	30.4	30.5	28.2	28	29
04.09.13	Temperature	AM	29.5	29.6	29.4	29.1	29.6	28	29	30
		PM	29.8	30	30.1	30.3	30.4	28.2	28	29
05.09.13	Temperature	AM	27.4	28.1	28.9	28.4	29.2	28.1	26.5	29.5

		PM	30	30.1	30.6	30.8	32.6	28.2	29.5	31
08.09.13	Temperature	AM								
		PM	32.1	32.3	32.4	32.6	32.7	28.4	30	31
09.09.13	Temperature	AM	29	30	30.1	30.2	31	28.4	29	31.5
		PM	29.6	30	31.2	30.6	32.9	28.4	30	31
10.09.13	Temperature	AM	28.8	29.5	29.8	29.8	30.2	28.2	29	38
		PM	29	30.5	30.8	31	31.7	28.5	29	30
11.09.13	Temperature	AM	29.1	29.7	29.8	30	30.1	28.4	28	30.5
		PM	31.9	32.4	32.5	32.8	32.9	28.5	30	31
12.09.13	Temperature	AM	31.1	31	31.2	31.3	31.6	28.4	32	41
		PM	32.8	33	33.2	33.5	33.6	28.6	34	33
14.09.13	Temperature	AM	30	30.8	31.3	31.8	32	28.8	28.5	28
		PM	30.8	32	31.9	32.2	32.9	28.9	31	32
15.09.13	Temperature	AM	30.1	30.3	30.5	30.6	30.9	28.4	31	42
		PM	30.8	31.4	31.8	32	32.4	28.8	31	33
16.09.13	Temperature	AM	31	31.2	31.3	31.7	32	28.6	31.6	33
		PM	32.8	32.9	32.9	33.1	33.2	28.8	32	33
17.09.13	Temperature	AM	29.9	31.6	31.6	31.8	32.3	29.1	31	43
		PM	32	32.8	33	33.9	35.4	29.6	31	33.5
18.09.13	Temperature	AM	30.1	31.1	31.3	31.4	31.6	29.2	30	33
		PM	31.8	32.1	32.5	32.7	32.8	29.4	32	34
19.09.13	Temperature	AM	31	31.3	31.5	31.7	32.2	29.2	31	41
		PM	32.2	32.6	32.3	32.5	32.9	29	32	33
21.09.13	Temperature	AM	31.6	31.8	32.2	32.7	32.8	29.2	31	35
		PM	32	32.6	32.8	32	33.1	29.4	32	34
22.09.13	Temperature	AM	31.9	32.2	32.4	32.5	32.7	29.4	31	32
		PM								
23.09.13	Temperature	AM	30.1	31.9	31.7	31.6	31.7	29	31	33
		PM	30.4	32.4	32.8	32.9	33.1	29.4	31.5	32

24.09.13	Temperature	AM	31.2	32	32.2	32.2	32.5	29.2	29	31
		PM	31.4	32.5	32.8	33.1	33	29.4	30	32
25.09.13	Temperature	AM	29.6	30.3	30.3	30.4	30.5	28.7	25	26
		PM	29.3	29.3	30.4	30.6	29.7	29.2	26	27
26.09.13	Temperature	AM	29.2	29.7	29.4	29.3	29.7	29.2	29	33
		PM	31.7	32.1	32.4	32.5	32.6	29.4	30	31
29.09.13	Temperature	AM	27.9	28.1	28.4	28.7	28.9	27.6	25	25.5
		PM								
30.09.13	Temperature	AM	26.5	27	27.1	27.2	27.4	27	24	27
		PM	27.1	27.4	27.5	27.8	28	29.2	25	25.5
Average			**30.18**	**30.75**	**30.97**	**31.10**	**31.47**	**28.70**	**29.39**	**32.07**
01.10.13	Temperature	AM	26.4	29.9	27.1	27.1	27.3	26.9	19	27
		PM	28.8	29.2	29.3	29.3	29.6	27.2	27	27
02.10.13	Temperature	AM	28.1	28.9	28.8	28.9	29.1	27	29	37
		PM	32.8	33	33.1	33.4	33.5	27.6	33	33.5
03.10.13	Temperature	AM	29.4	29.7	29.8	29.8	30.1	27.2	28.5	33
		PM	32	32.3	32.4	32.4	32.6	27.6	32	33
04.10.13	Temperature	AM	28.5	29.1	29.3	29.3	29.4	27.4	27	27
		PM								
06.10.13	Temperature	AM	26.6	27.2	27.3	27.4	27.6	27	24	24.5
		PM	25.9	26.1	26.4	26.5	26.6	26.8	28	28.5
07.10.13	Temperature	AM	27.6	28	28.1	28.3	28.6	27.2	28.5	31
		PM								
08.10,13	Temperature	AM	28.6	29.1	29.2	29.3	29.4	27.4	29	33
		PM	28.9	30.2	30.2	30.3	30.5	27.4	29	30
09.10.13	Temperature	AM	28.2	28.5	28.6	28.7	28.9	27.4	29	30
		PM	28.6	28.9	29.3	29.4	29.6	27.6	30	31
10.10.13	Temperature	AM	28.8	29.6	26.3	29.4	29.5	26.6	30	35
		PM	32.5	33	33.1	33.2	33.4	27.2	32	33

13.10.13	Temperature	AM	28.9	29.2	29.4	29.6	29.9	28.1	27.5	33.5
		PM								
20.10.13	Temperature	AM	31	31.2	31.5	31.6	30.8	27.6	29	31
		PM								
21.10.13	Temperature	AM	30.6	30.8	30.9	31.1	31.3	27.6	30	31
		PM								
22.10.13	Temperature	AM	27.7	28	28.1	28.1	28.3	27.4	25.2	27
		PM	27.7	28.1	28.1	28.2	28.4	27.4	26	27
23.10.13	Temperature	AM	26.6	26.4	26.4	26.5	26.7	27.4	27	28
		PM	26.4	26.5	26.7	26.7	26.9	27.4	28	29
24.10.13	Temperature	AM	25.8	26.1	26.3	26.4	26.3	27.2	27	28.5
		PM								
27.10.13	Temperature	AM	25.2	25.3	25.6	25.9	26	27.2	25	29
		PM								
28.10.13	Temperature	AM	27.1	27.4	27.6	27.7	27.9	27.2	27	26
		PM	27.4	27.7	27.8	27.9	28.4	27.2	28	29
29.10.13	Temperature	AM	27	27.1	27.2	27.5	27.6	27.1	26	29
		PM	27.2	27.4	27.6	27.8	27.9	27.2	28	28.5
30.10.13	Temperature	AM	27	27.2	27.3	27.4	27.5	27	26	29
		PM	28.1	28.9	29.2	29.4	29.9	27.6	28.5	29.5
31.10.13	Temperature	AM	27.2	27.6	27.8	26.9	27.1	27.2	25.5	27.5
		PM								
Average			**28.21**	**28.68**	**28.62**	**28.79**	**28.96**	**27.29**	**27.77**	**29.88**
03.11.13	Temperature	AM	25.7	26	26.2	26.3	26.6	25.9	25	28
		PM	26.2	26.5	26.6	26.8	26.9	26	26	28
04.11.13	Temperature	AM	26.1	26.2	26.6	26.8	27	25.8	26	29.5
		PM	25.9	25.8	26.1	25.9	26	25.9	28.5	29
05.11.13	Temperature	AM	25.2	25.5	25.7	25.8	26.1	25.9	24	27
		PM	26.1	26.5	26.4	26.6	26.6	26.1	25	27.5

06.11.13	Temperature	AM	25.3	25.7	25.9	26.1	26.2	25.9	24.5	28
		PM	28.2	28.6	28.9	29	29.1	27.2	28	28.5
07.11.13	Temperature	AM	27.2	27.5	27.6	28.2	28.1	27.1	27	29
		PM								
10.11.13	Temperature	AM	27.4	27.8	27.8	27.9	28.2	27.2	28	31.5
		PM	27.5	27.9	28.2	28.4	26.7	27.4	28	29
11.11.13	Temperature	AM	26.8	27.1	27.3	27.4	27.7	26.8	26	29
		PM	27.1	27.7	28	27.6	27.9	27	26.5	30
12.11.13	Temperature	AM	26.4	26.8	27	27.1	27.4	27.8	26	29
		PM	28.4	28.7	28.8	29.7	30.6	27.2	27	28
13.11.13	Temperature	AM	26.6	26.7	26.9	27	27.2	26.9	27	29
		PM	27	28.2	28.8	28.9	29.2	27.4	28	28.5
17.11.13	Temperature	AM	26.5	26.4	26.6	26.7	26.8	26.8	26	28
		PM	26.8	27	27.1	27.5	28	26.8	26	27.5
18.11.13	Temperature	AM	25	25.1	25.4	25.7	25.6	24.6	24	27
		PM								
19.11.13	Temperature	AM	25.1	25.3	25.7	25.6	25.9	25	24	27
		PM	25.7	26.1	26.6	26.8	27.2	25.6	25	26
20.11.13	Temperature	AM	24.7	25	25.1	25.4	25.6	23.3	24	26
		PM	25.2	25.4	25.5	26.2	26.8	24.2	25	25.5
21.11.13	Temperature	AM	24.7	25.1	25.2	25.3	25.4	24	24.5	25
		PM								
24.11.13	Temperature	AM	24.9	25.1	25.2	25.3	25.5	23.8	25	27
		PM	26.6	26.8	27.2	27.6	27.9	25	25	26
25.11.13	Temperature	AM	23	23.2	23.6	23.7	24.1	25.5	23	25
		PM	24.1	24.8	25.1	25.4	26.2	23	24	26
28.11.13	Temperature	AM	26.4	27.4	27.3	27.5	28.3	23.1	25.5	23.5
		PM								
Average			**26.06**	**26.40**	**26.61**	**26.81**	**27.03**	**25.81**	**25.72**	**27.60**

Annex-D

Gross return of total stored potato

The following equation (same as equation no. 1) used to calculate the gross return over farmer's practice and is shown in the following table

Gross profit in improved storage over farmer's storage in a month (Tk/kg) = (unit market price of potato, Tk/kg)[(% of potato saved) - (price loss factor for sprouting)*(% loss difference due to sprouting) - (price loss factor for shrinkage)*(% loss difference due to shrinkage)]

Table D1. Gross Profit in improved potato storage bin over farmer's traditional storage for a total storage capacity of 960 kg of potato

Month	Unit	May	June	July	Aug.	Sept.	Oct.	Nov.
Diamant Variety	Tk/kg	0.1261	0.19565	0.25425	0.4627	1.00815	1.4882	1.33875
	Tk	121.05	187.82	244.08	444.19	967.82	1428.67	1285.20
Lal Pakri Variety	Tk/kg	0.3483	0.4797	0.621	0.9612	1.1646	1.665	2.5669
	Tk	334.37	460.51	596.16	922.75	1118.01	1598.40	2464.22

Note: Calculated with a price loss factor of sprouting, 0.1 and price loss factor for shrinkage, 0.8